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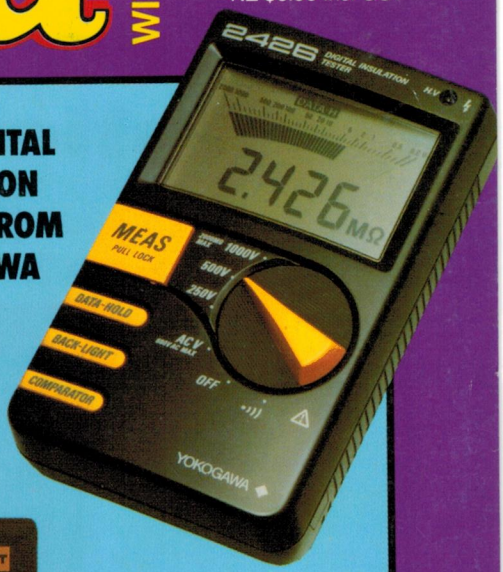
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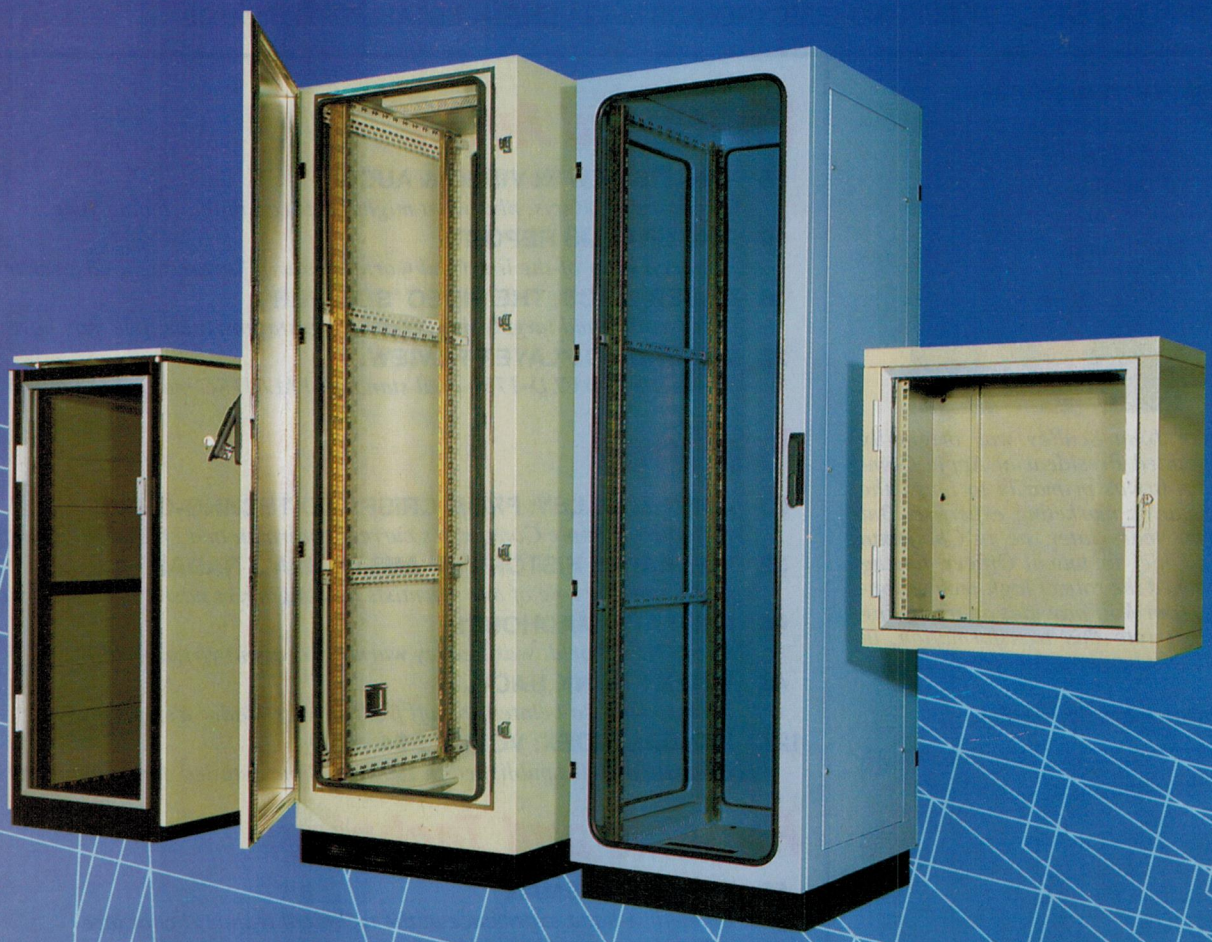
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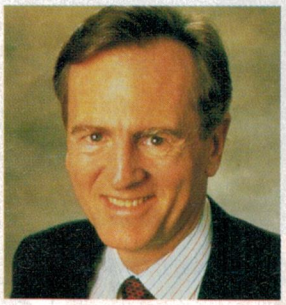
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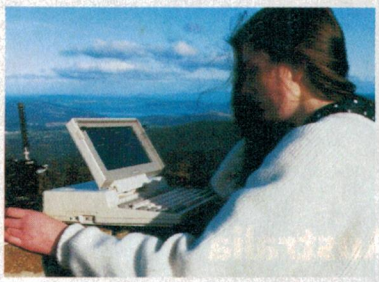
AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

High-tech visionary



When John Sculley was originally appointed President at Apple Computer, it was primarily to boost the company's marketing expertise. But seven years later, he is Chairman and Chief Technical Officer, having assumed the role of high-tech visionary. Tom Wolf provides an intriguing insight into this transformation, in his story beginning on page 28.

Cheap *and* portable...



Tom Moffat's new 'Pocket Packet' modem will turn almost any IBM-compatible PC into a packet radio terminal, at low cost. It will even work with a laptop and a handheld rig — see Tom's story, on page 84.

On the cover

Some of the more impressive late-model electronics products: Sony's new NT-1 digital dictation recorder, with its miniscule cassette; Hewlett-Packard's compact new Deskjet Portable printer; Yokogawa's Digital Insulation Tester; and Scope's new PX-1 Soldering Station.

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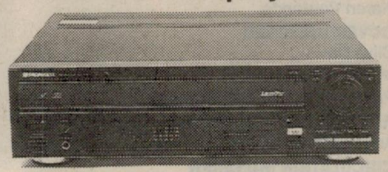
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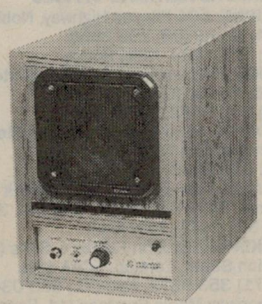
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PAL/NTSC disc player



Pioneer's new CLD-1750 Laserdisc player will play American NTSC video discs through a standard PAL monitor (or a TV with direct video and audio inputs), as well as PAL discs. It will also play standard audio CD's, as Jim Rowe explains in his review starting on page 22.

Getting better sound...



Rob Evans' new Multi-Media Mini Amp can boost both the volume and quality of sound from your computer or personal CD/tape player. It's low in cost, too. See page 74...

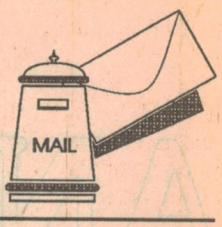
Upgraded Powermaster



One of our most popular 13.8V power supply designs has been upgraded, as you'll see on page 66. It now boasts a meter, a new case and a handy overload reset button.

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LETTERS TO THE EDITOR



Valve amplifier

As the designer of the Valve Amplifier in question, I would like to respond to Mr Seibright on two main issues. Firstly, the sound quality of valve amplifiers and secondly, the price charged for the kit.

1. Valve amplifiers are being widely used by many audiophiles throughout the world for musical reproduction. In my opinion valve amplifiers excel in areas such as midrange and the treble, which a sub-$1000 transistor or MOSFET amplifier cannot even match. However, it must be noted that the latter do in fact, have a better bass performance.
   In essence, the sound reproduction of both types of amplifier are different. Therefore, it is a matter of preference for each individual listener. If Mr Seibright has not heard one, please drop into your nearest hi-fi shop, which will no doubt, have one on demonstration.
2. Every year, Australia imports hundreds of valve amplifiers from the States and the United Kingdom. A similar valve amplifier to the Stereo Eighty costs about $2500 compared to Stereo Eighty which costs $1249. I believe this is value for money. At the same time I hope to play my part in fostering the local industries (transformers and chassis), and also help Australia in its balance of payments.

It may well be that Mr Seibright prefers MOSFET amplifiers to valve amplifiers, and he is entitled to do so. However, he should not condemn others who prefer valve amplifiers and at the same time, can afford to own one.

Tean Tan,
Mount Waverley, Vic.

BayCom software

In the November issue of your magazine Mr Tom Moffat, VK7TM, published an article about kits for PR-modems, supplied with a disk containing our PR-program BayCom. This is to tell you some facts about BayCom, which seemed not to be known to the author.

1. BayCom is not shareware and it may not be distributed freely. It is true, that you are allowed to copy the program for your private use, but it is not allowed to sell it or to give it for free with a commercial product (as these kits seem to be).
   In some older versions of BayCom these regulations were not clearly translated or removed later on, especially in these, floating through the BBS. We sell the program very cheap (below A$20), so everybody should be able to afford it.
2. The BayCom team is not located in England, but in Germany. All copyrights for software and main parts of the hardware are with Florian Radlherr, DL8MBT and Johannes Kneip, DG3RBU.
3. Our licenced partner in Australia is AAPRA, 59 Westbrook Avenue, Wahroonga, NSW 2076. Please contact Mr John Barrett, VK2AUQ.
4. In the last paragraph of the article, the program SP is mentioned. Please notice, that also this program is not public domain or shareware, it may not be copied. I have forwarded a copy of the article to the SP author, Mr Sigi Kluger in Munich..

We never wanted to make money with HAM-radio, but we cannot tolerate other guys marketing our products without our permission. There has been so much trouble with illegal copies — and this article shows one more, that we are planning to forbid any copying of the program beginning with the next version.

I would ask you to publish the given facts in your magazine and to forward this letter to Mr Moffat. We ask him urgently, to stop his activities on BayCom immediately, to prevent further trouble.

J. Kneip, DG3RBU,
Regensburg, Germany

Comment: We have published this letter as you request, Johannes, and also sent a copy to Tom Moffat — who immediately stopped supplying the program with his kits. Tom was only doing this as a courtesy anyway, to help people get started in packet radio — there was no intention to 'take advantage' of your work.

High voltage probe risk

I am writing to ask for your assistance in alerting your readers to the potential danger associated with High Voltage Probes as used in testing television receivers, transmitters and

other equipment requiring high voltage measurements.

The result of a recent coronial inquest in this State has highlighted the dangers associated with the use of such test equipment.

The victim in this incident was a qualified 'A Grade' Licensed Electrical Mechanic who was testing a Radio Frequency Welding machine. He had extensive experience in testing and repairing this type of equipment.

The test instrument used in this instance was a Leader High Voltage Probe LHM 80 which was designed to measure voltages up to +25,000 Volts DC. However, care must be taken when using any test instrument on live electrical equipment.

Also ensure that the test equipment is maintained at earth potential. It is essential that the earth clip is connected and securely attached to the earthed frame. Serious injury or fatality can result if the earth clip is not securely connected to earth, or is at any time connected to the 'hot' side of any high voltage circuitry.

This incident has highlighted the need to ensure that:

- tools and equipment are kept in good working condition;
- equipment is used within the manufacturers guidelines;
- the earth connection is intact and operative;
- extra care is taken when working in the vicinity of live electrical equipment

There has been an increase in the occurrence of electrical fatalities and serious electrical accidents involving electrical workers including engineers, technicians and mechanics in the past year.

We must all take greater care when working with any electrical equipment.

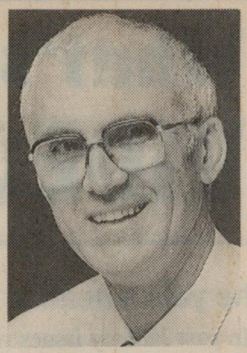
I request your assistance in warning your readers, many of whom are involved with the testing, repair and manufacture and design of electrical equipment that caution should always be exercised when working on live equipment.

R.N. Clark,
Chief Electrical Inspector,
SEC Victoria,
Melbourne, Vic.

DROP US A LINE!

Feel free to send us a letter to the Editor. If it's clearly expressed and on a topic of interest, chances are we'll publish it — but we reserve the right to edit those that are over long or potentially libellous.

EDITORIAL VIEWPOINT



Packed with interesting reading, despite recession and uncertainty...

Welcome to this, our first issue for 1993. As usual with our January issue, it's a special enlarged 'Annual Digest' edition, and despite the difficulties associated with the ongoing recession we've made a special effort to provide you with more than the usual helping of interesting and informative reading.

For example in the area of video and audio electronics, you'll find not only Louis Challis's review of the Australian-made Duntech 'Sovereign' speaker system (which is probably on the 'wish list' of most of the world's audiophiles), but *two* separate articles on the subject of video laser discs — the video product whose time may finally have arrived. One of these is an introduction and backgrounder on laser discs, by Barrie Smith, while the other is a review of Pioneer's new dual format PAL/NTSC disc player by yours truly.

Our general features include a very interesting profile of John Sculley, Apple Computer's current chairman, who has surprised the industry with his vision of its future. There's also the first in a short series of articles by Colin MacKinnon, telling the intriguing and hitherto largely secret story of how Australia's scientists and engineers developed radar equipment during World War 2. In the professional section of the magazine we also have an article which explains how the CDMA digital cellular radio system works — the first explanation I've seen that is actually quite easy to understand!

In his 'When I Think Back' column, Neville Williams begins a short sequence of articles on the development of public address or 'PA' sound reinforcement systems in Australia, from their first very crude beginnings as an offshoot from 'radio'. And in his own 'Vintage Radio' column, Peter Lankshear describes in detail the STC model 68, which was the first Australian commercial radio receiver to use octal-based metal valves.

Construction projects haven't been forgotten, of course. You'll find there are five designs inside: an updated and enhanced version of the very popular VK Powermaster 25 power supply, a compact but surprisingly good quality active speaker unit for improving the sound from computers and 'personal' music players, a low cost adaptor for using a PC as a packet radio terminal, a higher-power version of Rob Evan's very popular 'bandpass' subwoofer design, and a simple 'battery saver' circuit in Peter Murtagh's Experimenting with Electronics series.

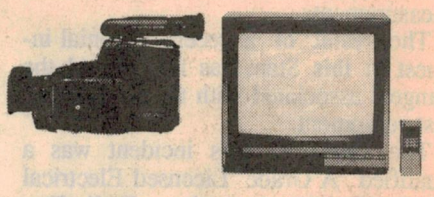
All of our other columns and sections are here, too — including a considerably expanded new products section as usual for January. So all in all, I'm confident that you'll find this issue outstanding value for money.

By the way, although you may not have heard much about Australia Post's new Print Post price hikes lately, or seen any consequences as yet, don't think that the problem has gone away. AP still seems determined to bring in the changes, which are due to come into effect in the next few months. This year is likely to be an extremely difficult one for many small Australian publishers, and if Print Post proceeds as they plan, you can expect to see many smaller and special interest publications hit the wall. We're determined that *Electronics Australia* won't be one of them, but it isn't going to be easy.

Our own company has recently launched a new magazine called *Australian Country Music*, for example — but isn't able to offer subscriptions to country readers because of the massive postage costs! Crazy, isn't it?

Jim Rowe

What's New in VIDEO and AUDIO



The year ahead...

In past January issues we have tried to look into the 'crystal ball', and make a few predictions about the likely trends for video, audio and other areas of consumer electronics during the coming year. However this year — perhaps because of the ongoing recession — the view ahead seems particularly cloudy, and predictions even more risky than usual.

In the TV and video area, the hot topic in Australia at the time of writing is still Pay TV — what form it will take, who the software providers will be, how many channels will be licensed and when it is likely to begin. The Government now seems to be reasonably committed to digital technology, but that's about the only thing that seems to have been decided. It seems unlikely that a service could begin during the current year, in any case.

In global terms, the European D2-MAC/HD-MAC system seems to be losing ground in the battle for proposed world HDTV systems, and many of the European firms seem to have joined the Americans in working on fully digital systems. Meanwhile the Japanese are still pressing on with their own HDTV system, with the country's national broadcaster NHK now transmitting signals for eight hours each day. Set prices have fallen from an initial 4 million yen (over A$40,000) to around 1.5 million yen, and are expected to fall further as the complex decoding circuitry is turned into LSI chips.

There is still quite a strong trend in Europe towards using the PALplus compatible enhanced-PAL system, as transition technology until HDTV is ready for the markets. However there are no signs that this may occur in Australia.

1993 *may* be the year that Laser discs finally 'take off' in Australia, as a higher-quality alternative to videotape for home viewing of pre-recorded movies. However although an industry group has been formed to promote PAL Laser disc players and software, as yet there has been little real promotion or marketing.

In the audio field, 1993 is likely to see a major world-wide battle for supremacy between the Philips-developed DCC (Digital Compact Cassette) system and Sony's MD (Mini Disc) system.

Both offer 'almost as good as CD' high quality digital audio recording and playback of both user-recorded and pre-recorded software, using special digital compression techniques. One uses compact tape cassettes and machines which will also play existing analog cassettes, and the other re-recordable magneto-optical discs 64mm in diameter.

Both DCC and MD were initially expected to hit the markets during 1992, but have experienced delays. Many industry observers believe that only one is likely to survive in the longer term, so competition in the coming year is likely to be intense.

In the rest of the domestic audio-visual market, surround sound processing finally seems to be becoming popular for enhancing the sound from TV, videotape and discs and creating a 'home cinema' viewing environment.

Large-screen sets and colour LCD projectors are also growing slowly in popularity, although the combination of high prices and the recession has inevitably acted as a brake on market growth.

Conventional analog 'vinyl LP' records and players have now virtually disappeared from the marketplace, apart from very expensive players intended for audiophiles.

That's about it, at present, in terms of the current state of the technology and where it seems to be headed...

Sanyo's 68cm CTV has auto controls

Sanyo's new TEICO (pronounced 'Teioh') large screen television comes in a glossy camphor wood cabinet and has a big 68cm (29") super flat screen. Virtually square corners widen the viewing angle, reduce glare and create a more natural picture with the same focus from its centre to the corners.

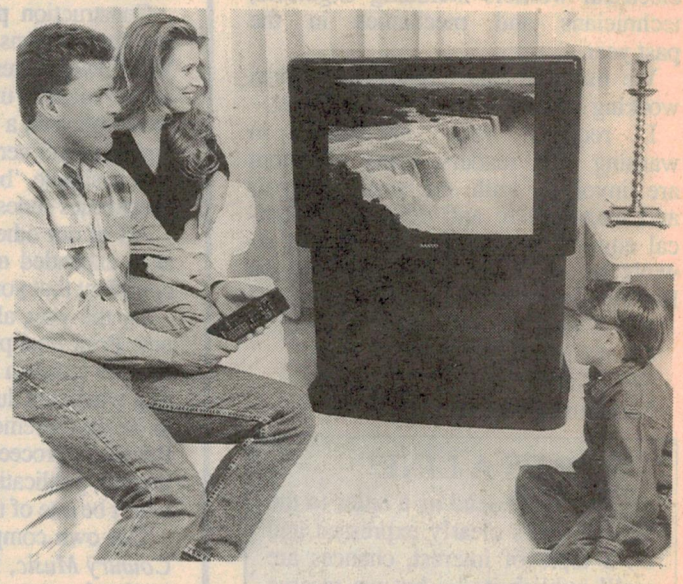
The set is also claimed to provide 750 lines of horizontal resolution, for a highly life like picture.

'Fuzzy logic' picture control circuitry continuously monitors the brightness of the room and the viewing distance, constantly adjusting image brightness to minimise eye strain. The fuzzy logic circuit also works to reduce picture noise.

Picture quality is further enhanced by the use of picture tube shadow mask made from Invar, an alloy of steel and nickel, to eliminate picture distortion caused by the tube's heat. A PAL/NTSC comb filter is also claimed to eliminate colour and dot interference for superior sharpness and definition.

Matching the TEICO's picture quality is a sub-woofer stereo sound system.

Other features include two inputs for S-Video and phono, a camcorder input, mini headphone jack and extension speaker terminals.



Sanyo's TEICO model CPP2940TX has a recommended retail price of $2999 and comes complete with a matching deluxe stand. It is available now from selected retailers of home entertainment products throughout Australia.

Sony's new big screen CTV's

Sony (Australia) has announced the addition of the new Kirara Basso Series to its multi-system Trinitron colour television line-up. Squarely targeted at the top-end of the television hardware market, the Kirara Basso Series features a slim bodied design and newly developed Super Trinitron technology.

The new Super Trinitron picture tube is claimed to provide the flattest screen available on the market, and is twice as flat in comparison to conventional Trinitron TV's.

Adding to the Trinitron's vertically linear screen, it prevents distortion of straight lines and ambient light reflection, and provides very faithful image reproduction.



Sony has ensured sharp focus and excellent picture quality corner to corner on the screen through the development of the new Superbrix Electron Gun.

With a larger lens and longer focal length than conventional tubes, it is claimed to achieve a 30% smaller beam spot. A new Aberration-free Deflection Yoke provides precise focus and reduces distortion by 10%. Combined with the Superbrix Gun, the result is super sharp electron beams and high resolution across the entire screen.

Natural, vivid colour has been provided through the adoption of European Broadcast Union (EBU) colour phosphor. As the standard used for broadcast master monitors, it extends the chromaticity range for richer colour reproduction.

The Natural Black Coating of the screen achieves colourless pure black and improves the contrast ratio by 70%.

Sony has also implemented a new Titanbright Layer and indium cathode said to increase overall brightness by more than 30% compared to a conventional picture.

New circuitry is claimed to enhance Super Trinitron's picture quality even further. A new digital comb filter for both PAL and NTSC pictures improves the resolution by 50% (PAL video in). Other circuitry such as velocity modulation, dynamic focus and dynamic convergence assures sharpness throughout the entire screen.

Enhanced bass and clear mid-highs are said to result from the Basso Speaker System through openings of just 2.8cm wide. Contained within its slim body are two 8-litre speaker boxes, which reproduce dynamic sound together with high power amplifiers of 15 watts per channel.

'Quest' system from Martin Logan

Martin Logan's 'Quest' is a hybrid loudspeaker system design, with the characteristic curved electrostatic panel combined with a large moving-coil bass unit.

Standing 1830mm high, the Quests represent an impressive and elegant speaker system. They are designed with small domed metal feet suitable for hard floor surfaces, but these can easily be replaced with adjustable spikes for carpet covered flooring. The centre of mass being low results in the Quests being very stable.

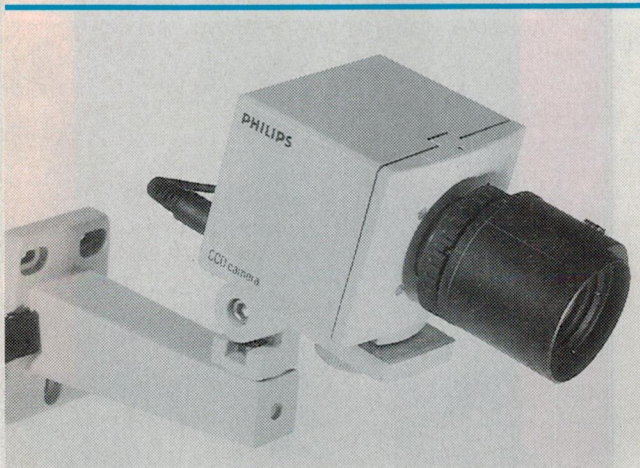
The grille conceals the electrostatic element, which offers a 30° beamwidth in the horizontal plane.

The full range panels cover frequencies from 125Hz to 20kHz without crossovers or tapped sections, and comprise a single Mylar diaphragm, self-supporting and operating over crucially defined sectors by foam spacers.

The outer spaced electrodes are also self-supporting and coated with a 10kV voltage proof material of a proprietary delrin/nylon composition. The transparent diaphragm operates under constant charge push-pull conditions. It is only 13um thick, with a uniform highly resistive palladium copper oxide layer said to be only 20 atoms thick.

The bass unit is loaded by a 40-litre infinite baffle enclosure that is overdamped to achieve a tapered response below 50Hz, designed to match the bass characteristics of a typical listening room.

The Martin Logan Quests are covered by a three-year parts and labour warranty and have a recommended retail price of $11,995. For further information contact Kedcorp on (02) 704 4388.



Colour camera for low light conditions

A new Philips colour CCD camera is able to produce colour images regardless of lighting conditions. The LDH 0801/20 possesses extremely high resolution and sensitivity, and is suitable for safety and security applications where previously only monochrome cameras could be used. With the ability to produce good colour pictures below the 1-lux level, the LDH 801/20 overcomes problems of picture-degrading noise at low light levels without sacrificing the colour of the image.

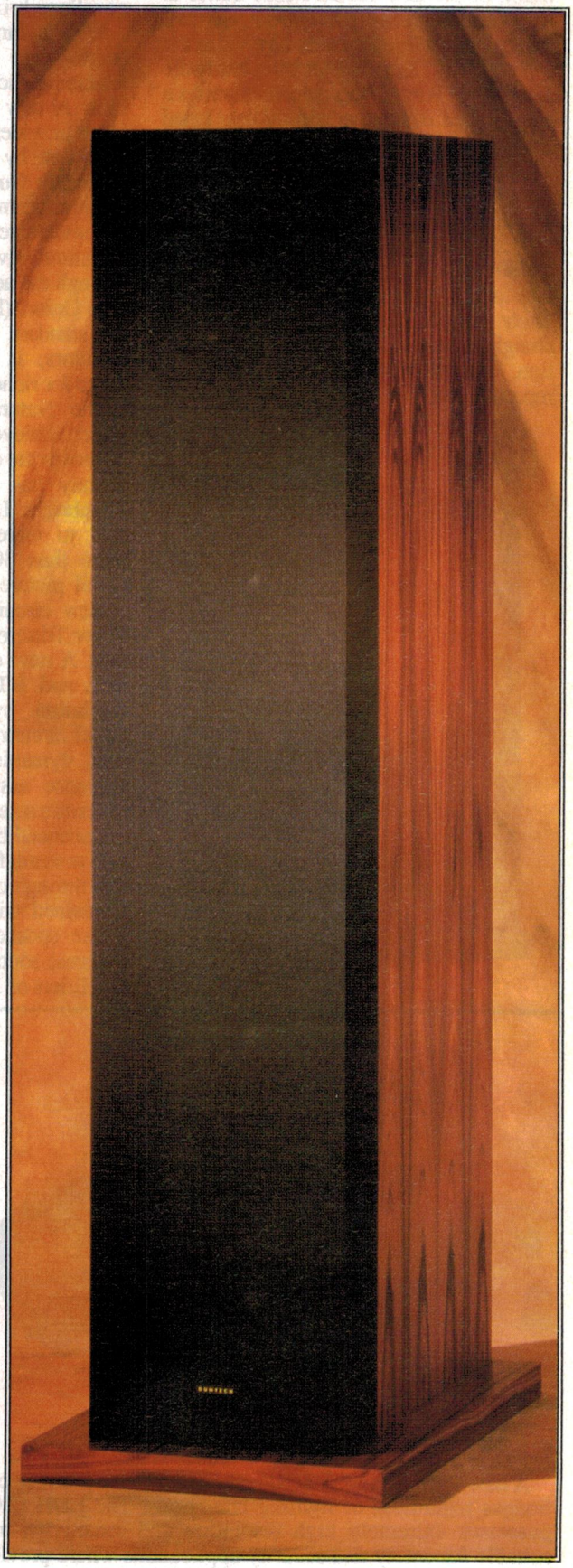
This is claimed as a breakthrough in its field. It allows differentiation between objects and their background even when contrast is extremely low.

The result is effective and rapid identification of potential intruders in all ambient conditions. High reliability is a feature of the camera. Developed and tested to meet international standards, it has a mean time between failures of 90,000 hours. Compatibility is another strong point, allowing integration into existing CCTV systems.

Two-dimensional fine tuning matches the colour to that of multiple cameras in a system. Output options include PAL video signal, two-wire balanced video, and an optional Super VHS compatible output.

The camera can be mounted from top or bottom, by a stanard 1/4" 20UNC screw. Power supply is an integral 230V AC unit, with optional modification to 114V AC if required. Operation from a 12V DC supply is also possible, via the system connector. ❖

DUNTECH'S 'SOVEREIGN' LOUDSPEAKER SYSTEM



This month, Louis Challis has finally been able to test and evaluate what most audiophiles regard as the best loudspeaker system in the world: the almost legendary Duntech Sovereign. Most Australians have probably never even seen or heard one, despite the fact that they're made right here in Australia — so we're sure you'll find his report interesting.

All too often some Australians take an entrenched position and think that just because a product is imported, it has to be better. I believe one example of where such views are not supported, is the case of the Duntech 'Sovereign' loudspeakers.

As I recall, it was in 1982 that I was invited to Canberra to meet John Dunlavy. John had recently migrated there, after having decided that Australia offered a better environment in which to bring up his two teenage daughters, than would the USA. John had set up a fairly complex facility in Fyshwick (in the ACT), where he had constructed a hemi-anechoic chamber, as well as a radio frequency screened room. With the help of an assistant, he was busily conducting measurements on a series of prototype loudspeakers, which he told me he hoped to manufacture in Australia, with the primary intent of selling them back into the American as well as into the Far Eastern markets.

There were a number of prototype speakers in his laboratory, the majority of which were somewhat larger than most of the current competing speakers. As I recall, the largest was somewhat taller than I was, and I gained the impression that John believed that 'big was beautiful'. There were some advanced unveneered prototypes in adjoining premises and I was invited to partake in an 'ad-hoc' demonstration of their performance. What I heard convinced me that the prototypes were already achieving an unusually good bass response. The taped material used for those demonstrations also revealed that the prototypes were displaying an outstanding stereo imaging performance.

I acknowledged that I was impressed, and although we discussed the possibility of conducting a formal review on at least one of his speaker systems, when they were ready for marketing, for unknown and unremembered reasons, I heard no further on the subject, and a formal request for the review never eventuated.

I subsequently heard from one of John's friends in the ACT, that the Federal Government had reneged on one of its promises to provide John with a base load of R&D work, and equally sadly had apparently failed to provide the other important financial incentives, which had initially lured him to Canberra, instead of one of the major cities.

John's response was to move his family and his facility to South Australia, where he continued his work. Some years later, I read in an American magazine that he was in fact producing acclaimed speakers, some of which were being exported into the US market.

It was at least 10 years after my visit to Canberra that I met Carman Rossi, the Manager of Duntech Audio. He was displaying his company's products at the Winter CES at Las Vegas, and it was there that I bumped into him.

After my initial surprise at finding an Australian company displaying at Les Vegas, I suggested that it was time for us to review one of his Company's speakers. We decided right then and there, that the most suitable system for review would be the 'flagship' Sovereigns, as they epitomised what Duntech stands for.

Big, imposing

Over the last 22 years I have evaluated and listened to many large speakers, but even so, when it comes to comparative assessments, the Sovereigns lead in many different areas.

Not only are they the tallest speaker system that I have tested, (1868mm) but they also have the greatest (dimensional) depth of any speaker system (805mm) that I have reviewed. However, of all the parameters, the weight is potentially the most important parameter and they are also the heaviest speakers that I have tested (148kg each).

With those unusual parameters you can understand why we needed three strong carriers to safely move them into my anechoic chamber, and subsequently the same three strong men to get them into and out of my living room.

As you must by now have guessed, Duntech's have an unusually large 'footprint', and the height and depth give rise to a visual perception which is initially daunting. Whilst they do not really look out of place in my living room with its high and sloping ceilings, it seems to me that there would be relatively few living rooms which would look quite the same once they are graced by these speakers.



A cut away view showing the general construction of the Duntech 'Sovereign'. Note the felt surround.

As I discovered following their placement adjacent to the southern wall of my living room, they really do 'make a statement', and I suspect that quite a few of the future purchasers may well decide that they will buy them, just to make such a statement !

The narrow and imposing front of the each of the speaker cabinets are sensibly protected by means of a metal frame covered with fine black cloth. Once the cloth is removed, you can't help but be impressed by the vertical array of seven driver elements.

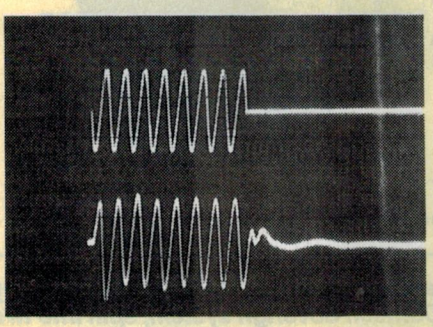
At the top and bottom of the front of the cabinet are two 300mm diameter woofers, each of whose central domes have been further modified by the application of large felt stars to reduce unwanted high frequency radiation. These drivers are of Dynaudio 80W100 woofers, and it appears that these unusual almost 'woolly' modifications were a natural outcome of Duntech's research to reduce unwanted spurious harmonically-related sound emission.

Immediately above and below these two speakers are a pair of 175mm diameter Dynaudio model 17W75 bass drivers. These are mounted on a pair of recessed planes, which are set back from the front of the cabinet. Each of these drivers is surrounded by a thick wool felt, which has been judiciously placed to reduce sound diffraction effects from the upper and outer edges of the cabinet's stepped profile.

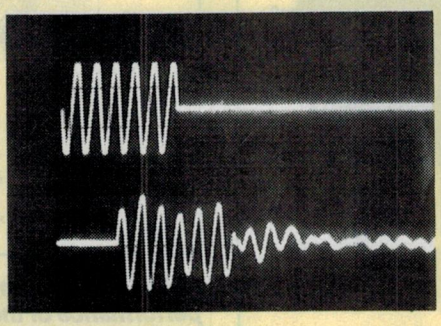
Closer to the centre of the cabinet, and on another inward step are a pair of 54mm diameter Dynaudio D52AF midrange drivers, with unusually large soft-domed diaphragms, which are also almost hidden behind the surrounding primary layer of thick wool felt. A second and more widely-spaced layer of felt has an exposed serrated profile, not unlike the foam wedges in my anechoic chamber. Obviously this approach has been taken to improve the high frequency sound absorption.

Right in the middle of the cabinet, some 980mm above the floor, is a single 19mm

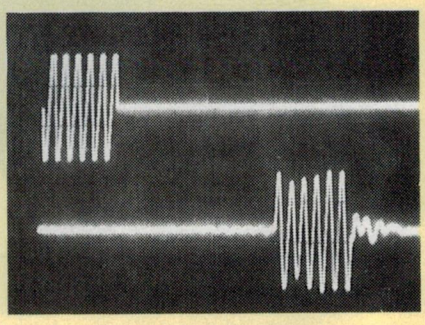
Toneburst response of Duntech Sovereign Loudspeakers (for 90dB Steady State SPL at 1m on-axis)
Upper trace is electrical input, lower trace is loudspeaker output



100Hz (20ms/div)



1kHz (2ms/div)



6.3kHz (0.5ms/div)

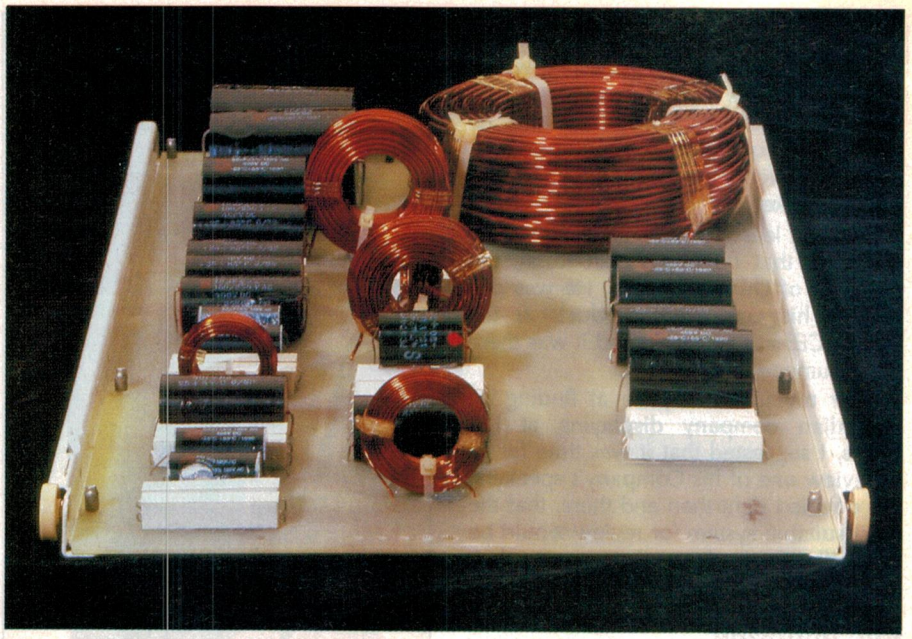
diameter Scanspeak D2008 tweeter, which is recessed behind a layer of felt. There is a relatively small open aperture in the face of this layer of felt, which ensures that the radiated sound field will suffer minimal adverse diffraction effects generated as a result of reflections from the face of the cabinet, or alternatively as a result of unwanted interaction with the adjacent drivers.

This particular tweeter is an excellent choice, and as our measurements confirmed, its frequency response characteristics right across its operating range are extremely smooth.

The time alignment of these speakers has been optimised for a listening position which is at least 3m out from the face of the speakers, and consequently some of our measurements which were performed somewhat closer, may not be as flat nor as smooth as they would be, had the measurements been performed at a greater distance.

The approach that Duntech have taken to solve their diffraction problems are 'natty', very practical and clearly effective. Problems associated with front-face sound diffraction have been the 'Achilles Heel' of many large and prominent loudspeaker manufacturers. Even now, it is remarkable how few speaker designers are aware of its criticality in achieving optimum overall fidelity for their products — or for that matter, how to address such problems.

The more driver elements that a speaker system uses, then the more difficult the problem becomes — particularly when each of the drivers has to work at too high a frequency for the physical diameter of the driver's cone, or dome. Duntech has been well aware of the problem and although their solution may not be visually elegant, it is nonetheless most functional and practical.



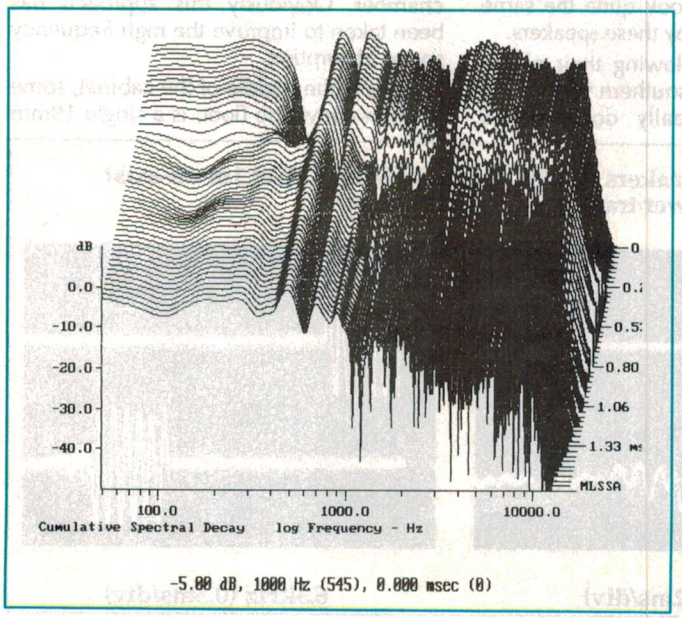
The crossover network components are mounted on a roll-out PC board assembly, located behind the recessed back panel. It employs large air-cored inductors, as you can see with high voltage prolypropylene capacitors.

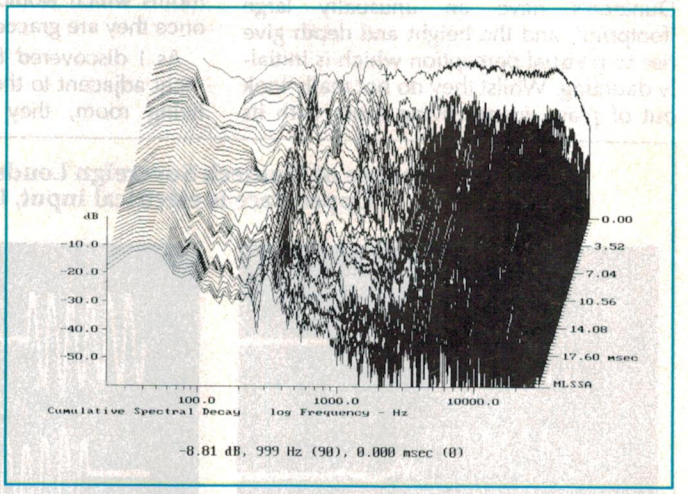
I opened up one of the enclosures to closely examine its internal construction, and soon discovered why the cabinet is so deep. This unusual configuration was apparently chosen on the basis that it offers a way of achieving a stiffer front face.

By utilising two layers of 18mm thick heavy MDF Board with an unusually large number of glued and screwed internal stiffeners, the end result is an extremely stiff and rigid structure, which re-radiates very little spurious sound from its external envelope. The outside face of the cabinets tested were veneered in American Oak, although I understand that other veneers like Brazilian Rosewood are also available.

The crossover network is located behind the recessed back panel, and incorporates large air-cored inductors and high voltage polypropylene capacitors in a first-order filter circuit. This has been designed for bi-amping, should this be desired, and in order to satisfy this need, there are a series of large gold-plated universal terminals (and related links) which will accept the cables from either a single amplifier's output, or the output from two separate amplifiers.

The terminals will accept banana plugs, spade lugs or thick bare cable connections, as required. As I noted the terminals are also at a sensible height, so that you





Here is the measured cumulative spectral decay performance of the Duntech Soverign system, split into two sections. At left is the response during the first 1.5ms, while above is the performance for the first 20ms or so.

Measured performance of Duntech Sovereign Loudspeakers
Serial No. B453

Frequency Response		24Hz to 22kHz	+/-6dB		
Crossover Frequencies		Nominally	250Hz	1000Hz	3000Hz
Sensitivity (for 90dB average at 2m)		12.0VRMS = 64 watts (nominal into 3.5 ohms)			
Harmonic Distortion (for indicated level at 1m)		**96dB 30Hz**	**96dB 100Hz**	**96dB 1kHz**	**96dB 6.3kHz**
	2nd	28.0	42.5	41.1	45.8
	3rd	43.3	47.6	51.3	55.8
	4th	47.8	68.3	69.3	65.8
	5th	61.7	50.3	57.2	-
	THD	4.1%	0.91%	0.93%	0.54%
Input impedance		63Hz	2.9 ohms		
		250Hz	4.5 ohms		
		1kHz	3.5 ohms		
		4kHz	3.2 ohms		
		8kHz	3.3 ohms		
Minimum at		63Hz	2.9 ohms		

don't have to crawl around the floor searching for them — as I did with a previous imported speaker system.

Objective testing

The objective testing was initially complicated by my inability to mount the Sovereigns on my Bruel & Kjaer turntable in the anechoic chamber. Had this option been available to me, I would have been able to generate polar plots — which I would normally regard as an essential component in such testing.

Each individual cabinet weighs 50% more than Bruel & Kjaer's specified upper weight limit for the turntable. This large mass, combined with unusually large base dimensions and our inability to determine the cabinet's centre of gravity, convinced me that I would end up destroying the central shaft and bearings. Faced with what I perceived to be a 'no win' situation, I applied very conservative logic — and decided to keep my turntables intact for the next and hopefully somewhat lighter set of speakers.

As I quickly discovered, the 'on axis' frequency response is determined by the location at which the measurements are performed. Up close, the measurements are inaccurate as a result of interference effects between the individual drivers; whereas to perform the measurements at 3.5m or 4m with the face of the loudspeaker already 2m out from the far wall of the chamber, would have exceeded the available spatial capabilities of the chamber itself.

Faced with this new set of factors, I chose to perform the primary measurements at a distance of 2m from the face of the speaker. Even then the frequency response was particularly smooth, although I suspect not quite as smooth as it might have been at 3.5m.

The 'on axis' frequency response is unusual, and it should be noted that I have seldom seen a loudspeaker system designed for consumer use with a better low frequency response, especially as its output is only 6dB down at 24Hz. The 'on axis' response is relatively smooth all the way up to 20kHz, with a couple of small peaks and bumps, the most significant of which are associated with the interference between adjacent speakers, particularly at the bottom end of the spectrum.

The top end of the spectrum is very smooth, with maximum deviations that are generally less than +3dB. An examination of the outputs of the individual drivers reveals that the nominal crossover frequencies appear to be set at approximately 250Hz, 1kHz and 3kHz.

These crossover frequencies have been selected to ensure that the individual drivers minimise the extent of piston diameter diffraction effects on the adjacent higher frequency drivers. Without my Bruel & Kjaer turntable, I was reduced to assessing the directionality of sound output by way of a limited number of measurements at appropriate angles off axis.

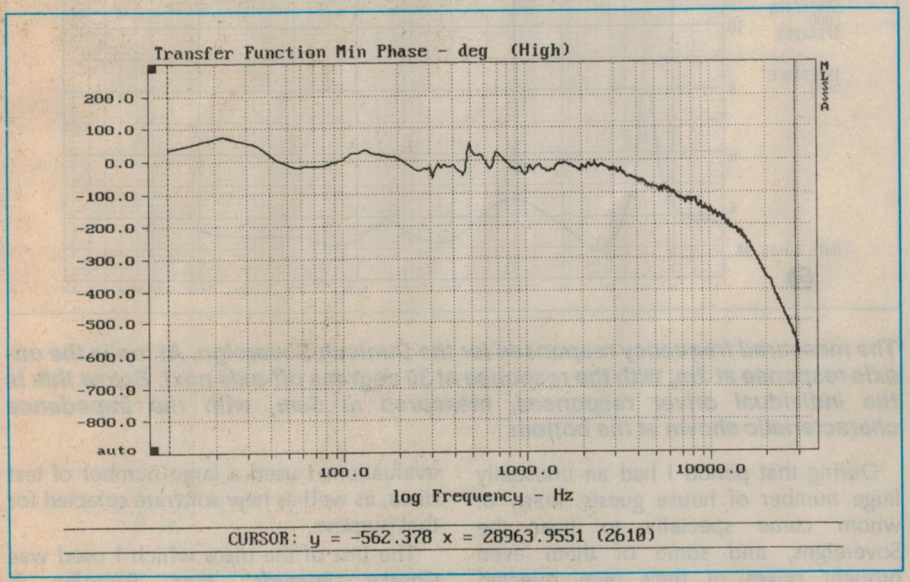
The response measured at 30° off the central axis is most commendable, and is almost as flat as it is 'on axis'. At wider angles off axis, the high frequencies drop off fairly rapidly, and particularly the components above 10kHz.

Frequency response measurements at 1m on axis, or closer when performed on a speaker with dimensions as large as those of the Sovereigns may be misleading, and are generally inappropriate unless performed for a specific purpose — like determining the individual outputs from individual drivers.

The design of the Sovereigns is predicated on the listener being located 3m or more distant from the face of the speakers in order for the individual sound components to be correctly time aligned. This is a very important requirement, and consequently, unless the Sovereigns are evaluated in an appropriately sized room you will never gain their full advantage, nor their full potential.

Our assessment of the total harmonic distortion figures, when measured at 1m on axis (for measurement convenience), also displayed excellent results. Don't be fooled by the distortion measured at 30Hz, whose numerical value is moderately high.

I don't normally measure speaker distortion at that frequency, as most other speakers would produce distortion figures which would be at least five if not 10 times higher than the value which the Sovereigns displayed at that frequency. Unlike most other speakers, and particularly vented enclosures, the overall low frequency power output capability



Here is the Duntech Sovereign's transfer function for group delay, showing how smooth it is in the critical higher frequency region above 1.5kHz.

and more importantly the related output distortion capabilities of the Sovereigns are exceptional.

The tone burst characteristics of the Sovereigns are good at low frequencies (100Hz) and good at high frequencies (6.3kHz), but are not quite as good at 1kHz where there were signs of ringing — which also showed up in the transfer function for group delay in the 500Hz to 1.2kHz region.

The transfer function for group delay at higher frequencies, and particularly between 1.5kHz to 30kHz, is very smooth, and this parameter has significance in terms of your audible perception of the stereo imaging capabilities of these speakers.

A examination of the input impedance of the speakers reveals that there is one dominant peak, of just under 8Ω at 30Hz, which surprisingly was precisely the frequency at which we measured the low frequency distortion. There is another modest peak of 4.5Ω at 200Hz, and thereafter the input impedance curve is relatively smooth from 400Hz all the way up to 20kHz.

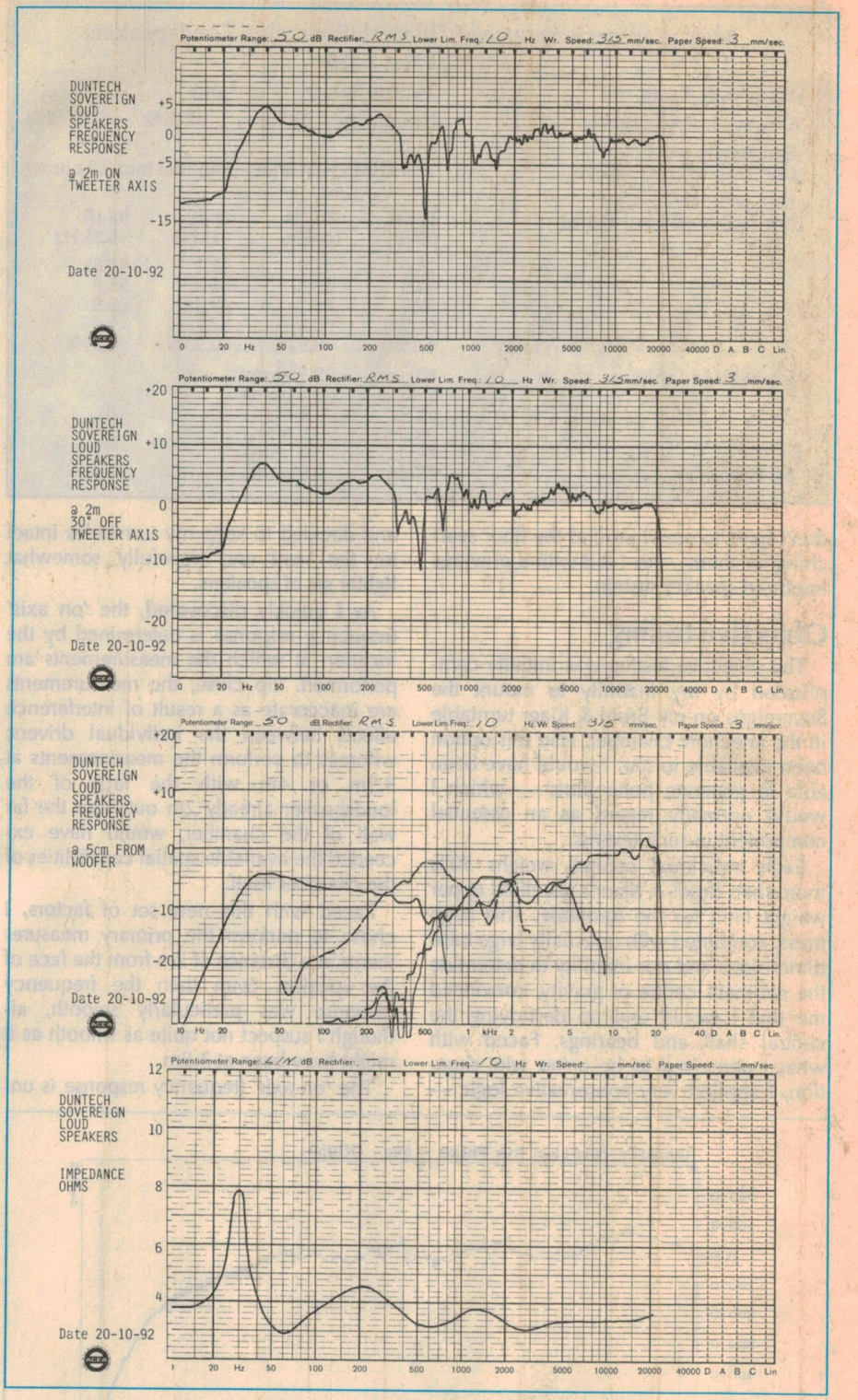
With these characteristics the speakers should be really described as a 3Ω system in terms of the IEC requirements, and reference to input power measurements and a nominal 8Ω are somewhat misguided. Notwithstanding, with such a low impedance, you do need an amplifier that is capable of providing high current, and which is not upset by impedances dropping down to 3Ω over a considerable portion of the frequency range.

I had some fun measuring the cumulative decay spectra, which revealed the presence of some significant resonances, the most obvious of which is close to 500Hz. Another and less persistent resonance is visible at 750Hz, whilst there are some further signs of low level decay resonance phenomena observable in the 800Hz to 1.2kHz region.

Whilst there are traces of some minor decay resonances visible at higher frequencies, they are fairly low in level and potentially insignificant. The only portion of the spectrum where there are any significant resonant decays is 'slap bang' in the centre of the mid-frequency region, and as I subsequently discovered, with some program content those characteristics are discernible.

Listening tests

After the objective testing was completed, and the pair of Sovereigns were ensconced safely in all their pride and glory in my living room, I auditioned them for more than a month.



The measured frequency responses for the Duntech Sovereign. At top is the on-axis response at 2m, with the response at 30 degrees off-axis next. Below this is the individual driver responses, measured at 5cm, with the impedance characteristic shown at the bottom.

During that period I had an unusually large number of house guests, many of whom came specially to hear the Sovereigns, and some of them even brought boxes of their own selected software with which to carry out the evaluation. For my own subjective evaluations I used a large number of test discs, as well as new software selected for that purpose.

The first of the discs which I used was Chesky Records' *Jazz Sampler & Audiophile Test Disc* (Volume 1, Chesky JD37). I must really acknowledge that I

was extremely impressed by the spatial localisation characteristics displayed by tracks 10 to 16 on that disc, and in particular by the Sovereign's performance on track 11, which is the 'Listening Environment Diagnostic Recording' track.

I have not yet heard any loudspeaker system which could out-perform the Sovereigns in terms of spatial localisation, when auditioning this particular test track. The response with track 14 'Solo Trumpet' and track 8 'Samba De Orfeo' were particularly noteworthy, and this is as close as you will get to a live recording at home.

I progressed on to a new recording of Mahler's Symphony No 4, with Barbara Hendricks as the soloist soprano and Esa-Pekka Salonen conducting the Los Angeles Philharmonic Orchestra (Sony Classical SK 48 380). I am convinced that this is an exceptional disc, and Esa-Pekka Salonen has produced an outstanding rendition of Mahler's very best and most beautiful symphony. The Sovereigns provided an outstanding performance, with a dynamic range and breadth of frequency response which was worthy of a concert hall.

Despite this, and because I was critically listening for any possible trace of mid-frequency colouration, I was able to detect it on Barbara Hendricks' soprano voice component. Whilst some of my listening panel were also able to detect these characteristics, the majority of my listening panel could not detect and were oblivious to them.

Even so, the orchestral component of the music was exceptionally good, and provided a degree of realism which was to say the least, memorable.

I progressed to another new record, with Carlos Kleiber conducting the Vienna Philharmonic Orchestra in the *1992 New Year Concert* (Sony Classical SK 48 376), recorded in Vienna's gilded Musikvereinssaal.

Apart from the opening Overture written by Otto Nicolai, the rest of the music consisted of lively polkas, waltzes and marches written by Johann Junior, Johann Senior and Josef Strauss. This music also provides an exceptionally wide dynamic and related frequency range, through which it is relatively easy to assess the quality of sound reproduction of the Sovereigns.

Once again the Sovereigns displayed their dynamic characteristics with an effortless ease. Input powers of 300 watts or more and output sound pressure level peaks approaching 106 decibels at my listening position were handled easily, although at these high levels the distortion level was starting to become significant.

The most frequently requested other demonstration disc that I used for my evaluations was Kathleen Battle and Wynton Marsalis in *Baroque Duet* (Sony Classical SK 46 672), which two of my guests brought with them — having recently purchased them overseas. I was pleasantly surprised, as this particular disc has only recently become available in Australia, and I have previously used it for my subjective assessments.

We used this disc, as both the trumpet solos and Kathleen Battle's magnificent voice are wonderful test material. It proved to be most appropriate in the circumstances, and once again, I could detect a traces of colouration in Kathleen Battle's beautiful songs.

It should be noted that had the speakers been less expensive, I would not have commented in the way that I have. With speakers at this price however, I am duty bound to highlight such a characteristic, even though most listeners would be entirely oblivious to their presence.

Summary

The Duntech Sovereign speakers display some truly outstanding characteristics. The most impressive of these is undoubtedly their spatial imaging capabilities. Without hearing them, you will never appreciate just how outstanding these speakers are.

The next most outstanding feature is their frequency response, which with the right sort of music — like the cannon's firing in Tchaikovsky's *1812 Overture* — has the ability to produce sounds that are about as true-to-life as you could hope or want to achieve in a residential situation. I listened to all four of my versions of this particular piece, and without exception each sounded more realistic than the performance provided by any other speakers.

Whilst I have described my experience with the Duntech Sovereigns, and I acknowledge that few of you are likely to be able to buy them, they are still worth listening to — if only to hear how well they reproduce the total content of the *1812 Overture*. Or should your taste be different, to listen to your favourite organ recital or rock concert, which I have no doubt they will reproduce with an absolutely awesome realism.

Now for the harsh facts and figures. Each Duntech Sovereign enclosure measures 354mm wide by 805mm deep by 1868mm high, and weighs 148kg (yes, each). The recommended retail price for the system is — wait for it — $19,995.00.

Along with the smaller Duntech systems, the Sovereigns are available from selected dealers in each state. Information regarding your nearest dealer is available from Duntech Audio, 60 Jacobsen Crescent, Holden Hill SA 5088 or PO Box 800, Modbury 5092; phone (08) 369 0600. ❖

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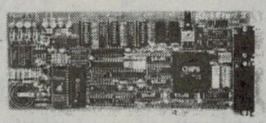
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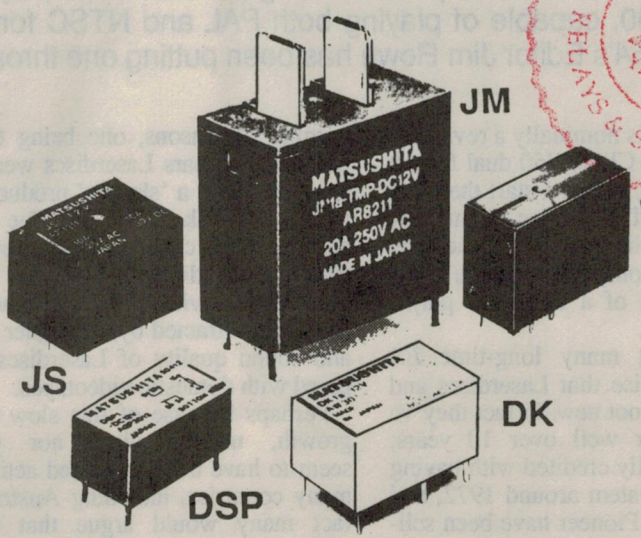
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READER INFO NO. 5

set. The audio was also fed through my stereo system, with 50W/channel driving a number of different speaker systems during my tests.

On the software side, Pioneer Australia very kindly arranged for Columbia Tristar Hoyts Home Video to loan me a couple of feature movies on PAL Laserdiscs, one of which was *The Last Emperor* (a favourite of mine, as it happens). I was also able to borrow a couple of movies on NTSC discs, from a collector friend of mine.

Pioneer also made available a PAL test Laserdisc, with a range of technical test tracks to allow the player's video performance to be evaluated. The disc also turned out to have a small amount of NTSC test information recorded on the reverse side, allowing limited evaluation in that mode also. And I was also able to use our Denon and Philips CD test discs, to evaluate the player's audio performance.

The video tracks on the test disc included multiburst, colour bars, a linear luminance staircase, $\sin^2$ (2T) pulse and bar, and a 20T pulse modulated with 4.43MHz. These were checked using a 100MHz scope as well as the Sony KX-14CP1, and the multiburst signal suggested that the luminance response of the player is 3dB down at about 3.9MHz — corresponding to a horizontal resolution of just over 400 lines. This is significantly better than domestic VCR's, of course.

The colour bars were clean, with quite crisp transitions, while the luminance staircase appeared quite linear. The 2T pulse measured almost 3dB down on the bar amplitude, though, suggesting a 'video quality factor' K of around 5% — relatively high by professional video standards, but probably quite reasonable for a domestic system. There was also a small single 'ring' after the pulse, but of quite a low amplitude — around 7-8%. Very little droop was evident on the bar signal (below 5%), suggesting quite good low frequency response.

The 20T modulated pulse had amplitude limits of 30% and 70% at the centre, suggesting that the response is noticeably down at 4.43MHz. But the concave underside of the envelope was quite symmetrical, suggesting very little differential phase shift between luminance and chrominance.

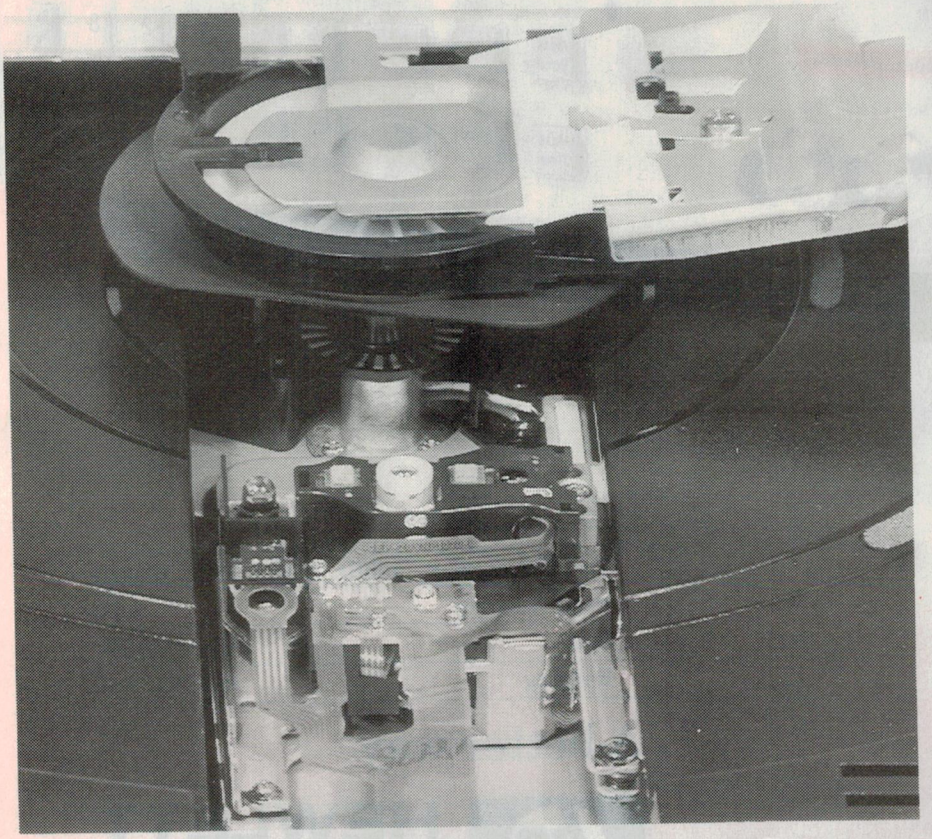
In short, then, the PAL video performance of the CLD-1750 seems rather better than that from a domestic VCR, as we've been led to expect from LD players. And as far as I could determine from the limited signals available on the 'flip side' of the test disc, the NSTC performance seemed fairly comparable.

The audio performance also seemed quite impressive, particularly for CD playback. The response of both channels measured flat within 0.3dB between 21.5Hz and 20kHz, and was in fact within 0.1dB between 40Hz and 18kHz. Signal to noise ratio measured better than 95dB unweighted, with channel crosstalk of better than -82dB over the full audio range. The impulse and squarewave tests showed a moderate amount of ringing, but it was fairly well damped.

In subjective testing using the movie discs, the CLD-1750 gave a good account of itself. The picture quality from PAL discs was very stable and with a noticeably lower level of visible dropouts and other noise, compared with that from VHS tape. At the same time, the resolution was significantly better, and very comparable with the video quality delivered by S-VHS or Hi-8.

The quality from NTSC discs seemed almost as good as that from PAL, although subjectively the pictures seemed to be lower in colour saturation, and a little lower in resolution. But this may have been due to the particular examples we tried; it wasn't easy to tell.

The sound reproduction was also much more enjoyable than delivered from tapes, with wider bandwidth as well as lower noise.



A close up of the player's laser pickup sled and disc drive mechanism. A single pickup is used to play all disc sizes and types. Note the slotted optical sensor disc mounted below the disc clamping boss.

Conclusion

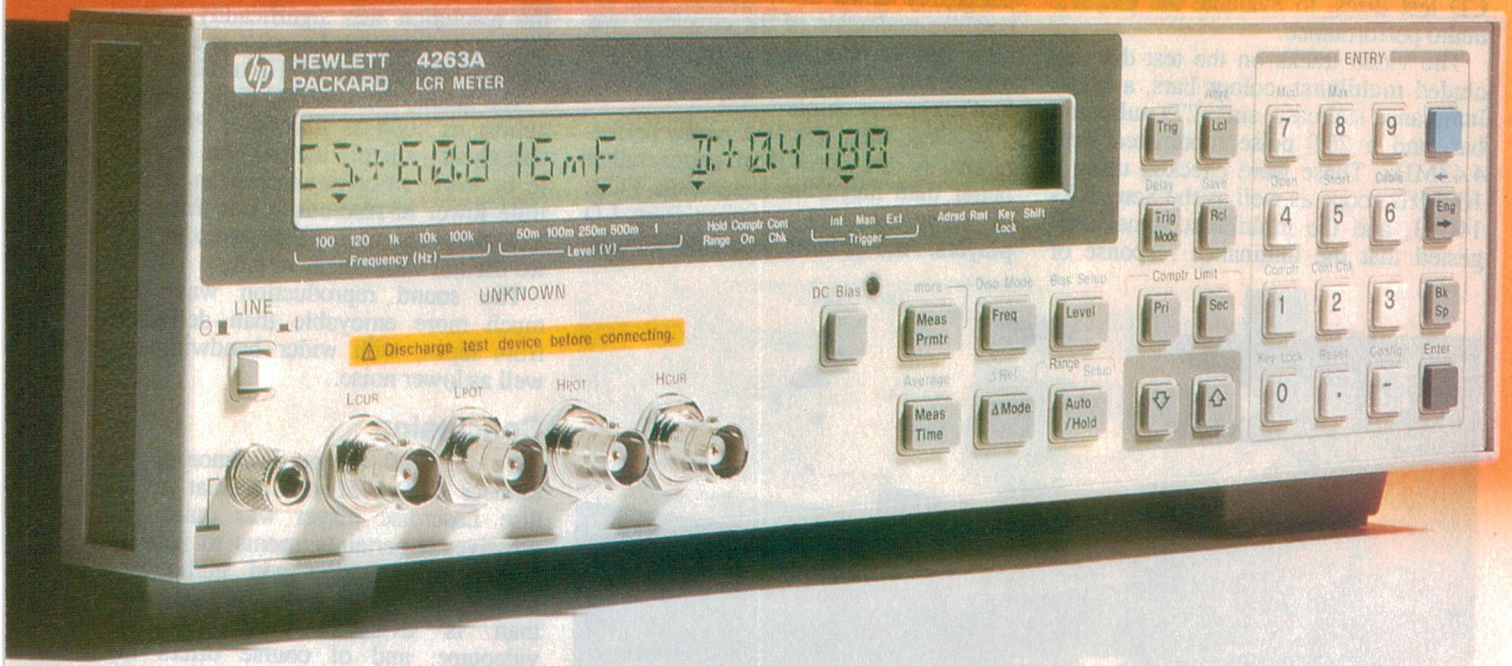
So all in all, the performance of the Pioneer CLD-1750 dual format multidisc Laserdisc player was quite impressive. It certainly seems to provide higher-quality video and audio, for those who want better reproduction than is available from domestic videotape, and of course offers the added advantage of compatibility with NTSC as well as PAL.

So it would seem an excellent unit for those who would like to provide themselves with an LD player, but don't want to either 'lock themselves out' of NTSC discs, or commit themselves to a full NTSC-only setup either.

Judging from the modest selection of PAL discs yet available, and the almost non-existent promotion of them to date, this player would therefore seem to be a very sensible one to choose.

The quoted retail price of the CLD-1750 is $1399, and it is available via Pioneer dealers. Further information is available from Pioneer Electronics Australia, 178 Boundary Road, Braeside 3195; phone (03) 580 9911. ❖

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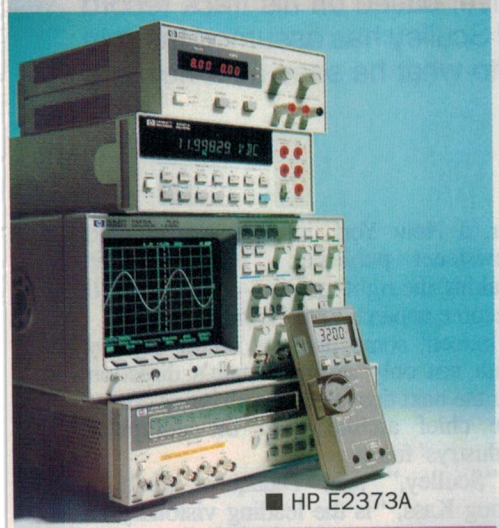
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Profile of a US industry leader:

APPLE'S SCULLEY: FROM CRISPS TO TECHNO-GURU

Apple Computer's current chairman and chief technical officer John Sculley was originally appointed by co-founder Steven Jobs to boost the company's marketing expertise, based on his track record with firms like Pepsico. But seven years later Jobs has long gone, and Sculley has assumed the role of high-tech visionary — re-arranging the company and dragging it into what he sees as a new era in personal communications...

by TOM WOLF

When John Sculley joined Apple Computer as President in 1985, he was hired for his marketing skills — definitely not to have any kind of major input on the direction in which Apple should take its products and technologies. Some even laughed at the notion that this Pepsi-and-potato-chip executive could run a leading-edge computer company.

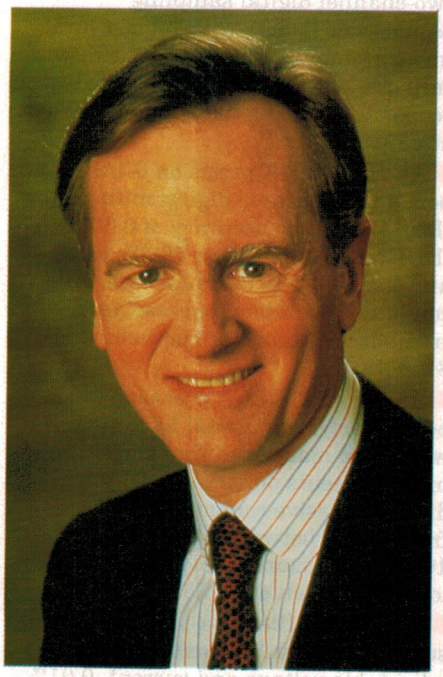
But today Sculley has assumed the visionary role that Steve Jobs once held. And Sculley, now as head of Apple's research operations is keeping Apple at the forefront of technology and — perhaps — launching the 1990's equivalent of the personal computer revolution.

In mid 1992, Sculley unveiled at the Consumer Electronics Show in Chicago a first generation PDA (personal data assistant) called 'Newton'. It is the first example of an 'information appliance' — a pocket-size portable computing device that millions of people could use for work, entertainment, personal organisation, education and communicating with people around the world.

Although its success is far from guaranteed, Newton is nonetheless critical. It represents perhaps the first tangible glimpse of a vision of technology's future, a vision now shared by many of the world's biggest high technology companies.

Many people now credit Sculley with shaping that vision, although he came to Apple as a savvy marketer and business organiser who was never expected to inherit Jobs' role as the guardian of Apple's technical vision.

That assessment has changed dramatically since Sculley named himself chief technical officer in 1990 and placed himself in charge of the company's most advanced research projects. Analysts say Sculley has demonstrated an unexpected comprehension of computer technology, and understands what consumers will want to do with it.



That, they say, may be the key to Apple's survival. As growth slows and profit margins contract in the personal computer business, Sculley's vision of the future could make Apple the leader in a new, and potentially far more lucrative market — what Sculley himself calls 'the mother of all industries'.

"When he took that job he was widely criticised within Apple, and widely laughed at without," said Richard Shaffer, a New York industry analyst and newsletter publisher. "But Apple is making the right moves — ones that will become apparent over the next year."

Indeed, some analysts credit Sculley with not only setting Apple's direction for the next decade, but with being one of the chief architects of the computer industrys' future.

"Sculley," said Dataquest analysts Doug Kass, "is the leading visionary in the computer industry today."

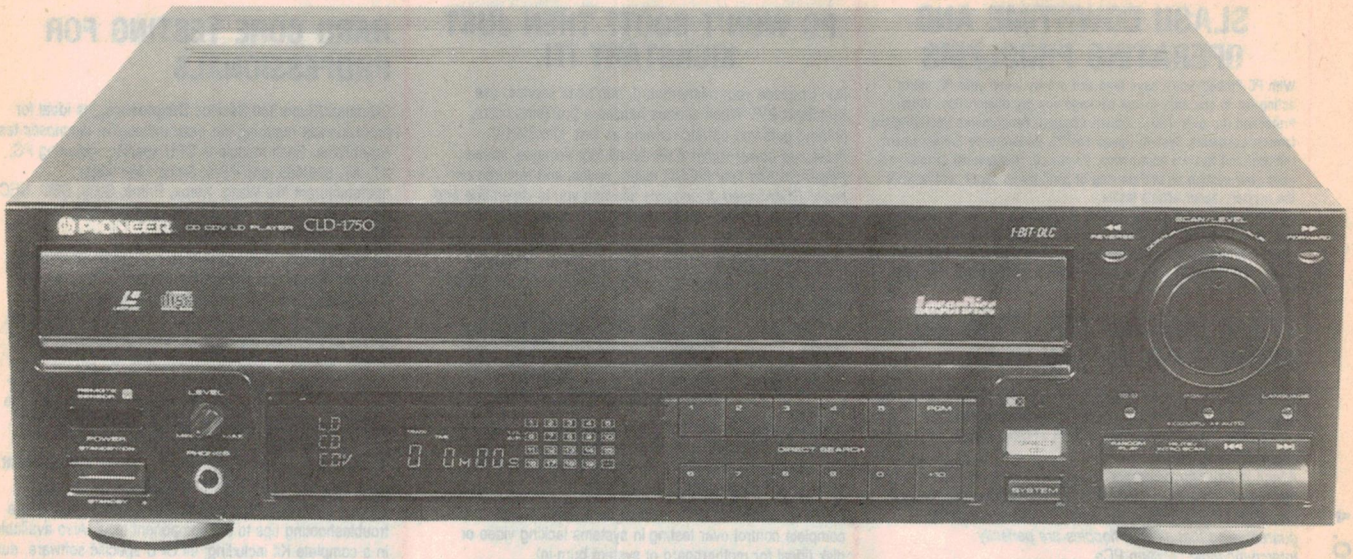
PDA's in view

It is a risky vision. Apple plans to finish the decade as a remarkably different company from the one Sculley forced Jobs to leave in 1986.

It is staking much of its future on an untested hope for Newton and similar devices. The potential, most industry experts agree, is huge. Their development, Sculley said, is inescapable.

"The winds of change are at our back on this one," Sculley said. "The world is going into transition from analog to digital, whether Apple is there or not. These things are going to happen. What Apple is focused on is how do we take advantage of that. This is just like how the appliance industry was created with the invention of the fractional-horsepower motor. The (personal electronics) industry is going to be bigger than anything we've seen in personal computers."

It seems likely the transition would have taken place if there had never been an Apple Computer, or if Sculley had never met Jobs. The seeds of this change were planted 20 years ago by another visionary, Apple Fellow Alan Kay and his vision of a 'Dynabook'.



PIONEER'S CLD-1750 PAL/NTSC MULTI PLAYER

A recent addition to the impressive range of Laserdisc players produced by Pioneer Electronics is the CLD-1750, capable of playing both PAL and NTSC format video discs in addition to standard audio CDs. *EA*'s Editor Jim Rowe has been putting one through its paces, and here's what he found.

Although this is nominally a review of the new Pioneer CLD-1750 dual format Laserdisc player, before I start there are a few aspects of Laserdisc technology about which I'd like to make some brief comments — if only because this is the first real review of a Laserdisc player we've ever done.

I'm sure that many long-time *EA* readers will realise that Laserdiscs and their players are not new. In fact they've been around for well over 10 years; Philips is generally credited with having developed the system around 1972, and both Philips and Pioneer have been selling both players and software since the late 1970's, in countries like the USA and Japan. Of course in many ways the audio compact disc is a development from Laserdisc technology, along with its recent offshoot the CD-Video disc.

Why then haven't we reviewed a Laserdisc player before this? There are a number of reasons, one being that for quite a few years Laserdiscs were what is often called a 'sleeper' product, even in countries like the USA. The market and software catalogs both grew very slowly, with discs and players bought mainly by movie buffs — who were the first to be attracted by the higher picture and sound quality of Laserdiscs, compared with domestic videotapes.

Perhaps because of this slow market growth, neither discs nor players seem to have been marketed actively in many countries, including Australia. In fact many would argue that they're *still* not being marketed here, to any significant extent. But firms like Pioneer have been quietly selling players here for a couple of years now, again mainly to movie buffs who have been bringing in NTSC format discs from countries like the USA.

Noticing the modest but spontaneous market growth, a few enterprising retailers began bringing in NTSC discs from overseas, and offering them for sale. The local offices of the main hardware and software firms saw this happening, and decided that this market-driven push for Laserdiscs should be 'steered' away from NTSC, and towards Australia's official PAL format. So they got together and formed an industry association, ostensibly to promote PAL Laserdisc technology.

As yet, though, you'd be excused for not having noticed the achievements of the new PAL Laser Disc Association of Australia (PLDAA). At the time of writing this, neither discs nor players are widely available in retail outlets, and the software firms in particular seem to be very quiet about promoting their wares.

Still, it looks as if the Australian market for Laser discs may *finally* be about to emerge, after what must be one

of the longest gestations ever for a consumer electronics product. And it's *that* likelihood that has prompted us to review a player, at long last. Until now, there just hasn't seemed much point.

Laserdisc pros, cons

Like compact discs, Laserdiscs are a playback-only medium, for prerecorded software. In this case the software is live video and audio, of course — feature movies, operas, music concerts and the like. And like compact discs, Laserdiscs are read using an infra-red light beam, so there is no physical contact between the recording medium and the 'pickup'. Hence unlike videotape, there is no wear problem.

The reproduction quality tends to be rather better than from domestic videotapes, too. Typically the video resolution is around 400 lines, with a signal to noise ratio and dropout level significantly better than with tape — giving a potential picture quality comparable with the S-VHS and Hi-8 'enhanced' video formats.

Virtually all Laserdiscs have full stereo sound, too. The earlier discs have FM analog sound, while most of the more recent Laserdiscs and CD-Video discs have digital audio, giving essentially the same audio quality as from a CD. Even the discs with analog sound tend to give better quality than from tape, thanks to the optical playback.

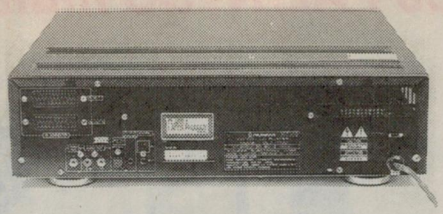
So the video and audio reproduction from a Laserdisc is significantly better than from a normal domestic VCR, and essentially as good as it's possible to get currently, from domestic equipment.

What about disadvantages? Well, there are really only a few, all of them perhaps only temporary. And how serious they are depends largely on your point of view.

Perhaps the most obvious disadvantage is that as yet, there are relatively few movie titles available on PAL discs. At the time of writing, about 90 have been officially released, which is still a 'drop in the bucket' compared with the 10,000 or more available in the USA on NTSC discs.

Another problem is that a typical feature movie on PAL Laserdisc tends to cost around $115 retail — around double the price on VHS videotape. This is quite a premium, and one which seems hard to justify on the basis of production costs. One would actually expect a Laserdisc to be *cheaper* to produce than a videotape, because it can be pressed in a few seconds, from about $5 worth of plastic.

A further disadvantage is that depending on length, a feature movie currently tends to occupy from two to four disc sides. Although there are Laserdisc players that automatically play both sides of a disc, most of the lower cost players require you to turn the disc over manually. This means that your movie viewing tends to be interrupted every 40 minutes or so, to turn over or replace the disc — not a major shortcoming, but a minor source of irritation.



At the rear, the CLD-1750 provides two SCART sockets as well as analog A-V and digital optical audio outputs.

Pioneer's new player

With those introductory comments out of the way, let's now look at Pioneer's new CLD-1750 player. This one seemed very appropriate for our first real look at Laserdisc players, because it's not only capable of playing a wide variety of disc sizes (including standard audio CD's), but is also one of the first to offer the ability to play NTSC discs on a standard PAL set, along with PAL discs.

How does it do this — does it have an inbuilt standards converter? No, I gather not. My understanding is that Pioneer and other manufacturers have worked out a relatively simple way to convert standard 525-line/60-field NTSC video into a 'pseudo-PAL' signal, capable of fooling most standard PAL receivers and video monitors into providing an acceptable picture. Presumably this involves synthetic toggling of the colour burst and chroma information, to allow the PAL decoder circuitry to operate correctly.



The player's remote control unit features a rotary 'shuttle' or scan control knob, as well as many buttons.

Small NTSC/PAL converter boxes working on this principle have in fact been available in video stores for a year or two, and selling for about $300.

But what both the CLD-1750 and these little converter boxes have in common is that they don't include a digital frame store — so they can't change the basic line and field rate. So the pseudo-PAL signals that emerge when you're playing an NTSC disc still have 525 lines per field and 60 fields per second, not the 625-lines/50-field combination used by Australia's standard PAL.

What this means is that for a stably locked picture, your set's vertical sweep circuitry must be able to lock to 60Hz as well as the standard 50Hz. Most reasonably modern sets will do this quite happily, either automatically with the latest models or perhaps after a bit of 'tweaking' of the vertical hold control, with earlier sets.

Not quite so easy to solve is the fact that the picture tends to be squashed vertically, because of the reduced vertical sweep produced when the circuitry is run at 60Hz instead of 50Hz. Some of the latest sets have provision for automatic switching to a 'boosted' height setting when a 60Hz field rate is detected, but in most cases you have to again tweak the height control manually, to get a full height picture. Then you have to tweak it back again, to watch normal 50Hz PAL...

Some enthusiasts have found this so irritating that they've had their set fitted with a special switch, to allow rapid switching of both vertical hold and height settings.

These are not major problems, of course. The main point is that a player like the new CLD-1750 will let you play either PAL or NTSC discs through a standard PAL receiver — providing it is fitted with a direct video and audio input, using either a SCART connector or BNC/RCA sockets. The player has both kinds of direct A-V output; in fact it has two SCART connectors, and also an optical digital audio output as well as conventional BNC/RCA analog outputs. However unlike many VCRs, it's *not* fitted with an RF modulator to allow input via a vacant

VHF or UHF channel — presumably because a modulator would degrade the signal quality significantly.

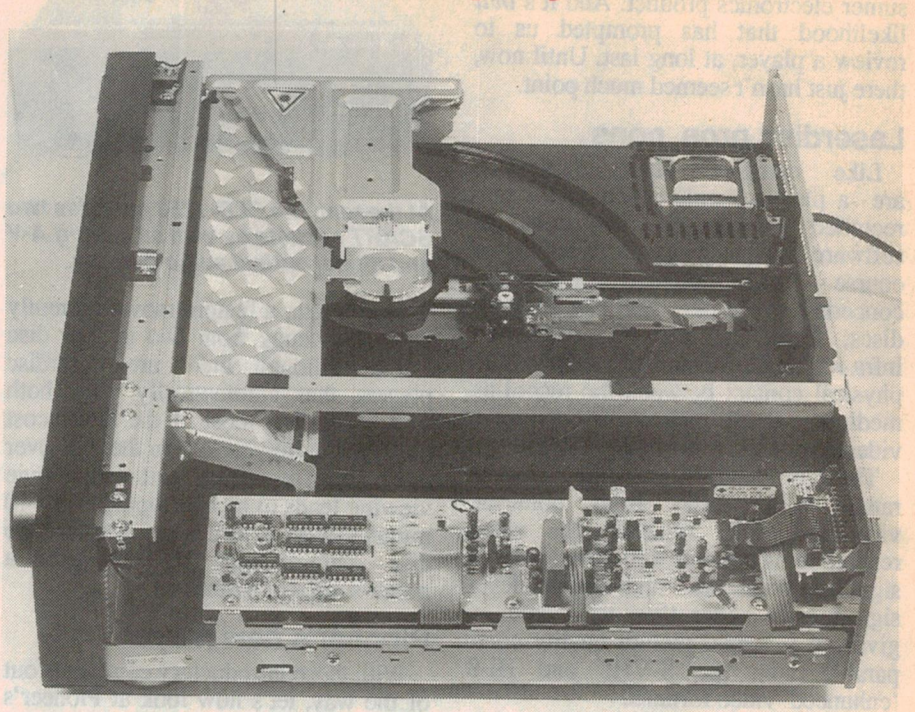
By the way since Laserdiscs have stereo sound, and also because the CLD-1750 will play both CD-V and standard audio CD's as well, it provides left and right stereo outputs which can be fed either directly to your hifi system, or via a surround sound processor. So if you wish, you can really use the CLD-1750 as the basis for a full 'home video cinema' system.

The CLD-1750 measures 420 x 418 x 122mm and weighs 8kg, making it a little larger than a typical VCR. It has a large roll-out tray like one of those 'carousel' multi-CD players, but in this case the tray takes only a single disc at a time. However that disc can be anything from a full 300mm double-sided Laserdisc right down to one of the little 80mm 'CD singles', as you wish. This includes standard 120mm CD's, CD-V discs of the same size and the smaller 200mm Laserdiscs.

Both standard-play CAV (constant angular velocity) and long-play CLV (constant linear velocity) Laserdiscs can be played, in both PAL and NTSC, and CAV discs can be both paused for still picture display and played back at nine different speeds, in either direction. Both CAV and CLV discs can also be 'scanned' in either direction at either 10x or 30x normal speed, using the large 'jog shuttle' or 'scan' control knob at the right-hand end of the front panel. (The player's IR remote control unit has a smaller knob, with the same function.)

Most of the CLD-1750's controls and displays are very similar to those of a standard CD player. For example there's a tray open/close button, a stop button, a play/pause button, forward and reverse track skip buttons, and a keyboard to allow immediate direct access to any desired track (or LD 'chapter'). And the fluorescent display shows the kind of disc being played, track/chapter number, frame number or time in the case of LD's, plus things like the player's mode/status. (But the CLD-1750 also provides an alternative display on the screen of your TV/monitor, selectable at will — and very convenient when you're using the IR remote.)

There *are* a few rather unfamiliar controls, though. For example there's a 'system' button, to let you manually over-ride the player's choice of video mode when it's playing a Laserdisc; there's also a '16:9' button, to expand the horizontal display for LD's that have been recorded in 'squeezed' mode, when you're using one of the new 16:9 sets. This latter button only works with the SCART video outputs, by the way, not the BNC output.



Inside, the player looks a little like an overgrown CD player. The PC board visible is only one of a number — another much larger board is under both it and the disc tray mechanism. The tray itself takes many disc sizes.

Other less familiar controls are a 'Direct CD' button, to disable the video processing circuitry when you're playing an audio CD (to reduce crosstalk); a 'HiLite/Intro Scan' button, which lets you sample 8-second snippets from each track of a CD or chapter of an LD; and a 'Language' button, which allows selection of English, French, German or Italian for the on-screen display.

The IR remote also has a 'Display' button, to select various on-screen display modes: no display/time elapsed/time remaining/chapter and frame number, and an optional stereo level meter. And it also offers a button which allows remote control of the audio output level, from CD's and LD's with digital audio. This gives a range of selectable levels between 0dB and -25dB, so if you set the maximum volume in the 0dB position, you can then adjust it remotely to lower levels.

Needless to say the CLD-1750 offers random play for CD's, as well as programmed playing and repeat modes. It also provides a 'CD Deck Synchro' jack on the rear panel, for control of a compact cassette deck when dubbing from CD's, and a pair of 3.3mm jacks for Pioneer's remote system control interconnections.

By the way, the digital audio conversion circuitry in the CLD-1750 is based on a single-bit D/A converter, which Pioneer describes as a 'zero-cross distortion free D/A converter with double-step noise shaper'. Apparently the D/A converter is designed to minimise zero-crossing glitches and improve linearity at lower signal levels, while noise shaping is performed during both the digital filtering and D/A conversion stages, to give a smoother and cleaner output.

The insides of the CLD-1750 look rather like those of an enlarged CD player, as you'd expect, apart from there being rather more PC boards and circuitry. As usual for a Pioneer product, everything seems to be well engineered and fabricated. I guess Pioneer has been making LD players now for so long that if they don't know how to make a good one, no-one does!

How it performs

I was able to try out the sample CLD-1750 player with both a Sony KX-14CP1 high resolution video monitor, and a couple of different standard PAL TV receivers fitted with direct A-V inputs — a 66cm set and a smaller 34cm

Video & Audio:

LASER DISCS: THE VIDEO 'SLEEPER'

Laser discs are currently being promoted (well, quietly!) as the latest and highest-quality way to watch feature quality movies on your home TV. But the subject of video format — NTSC or PAL — is becoming a thorny one.

by BARRIE SMITH

Karaoke — a name to strike fear in the hearts (and sensitive ears) of many a bar and restaurant goer. Every night across the land, thousands of amateur vocalists wrap nervous fingers around a mike, fix their eyes to a TV screen and belt out 'My Way', 'The Way We Were' and more.

The 'wannabees' — wannabe Sinatra, wannabe Streisand, and so on — whilst satisfying deep, hidden urges that would delight many a shrink, are probably unaware they owe their brief stay in the spotlight to 24-year old technology whose time may at last have arrived.

For 'karaoke', read 'laser disc'.

In June last year, a meeting took place of seven Australian hardware companies and five enterprises dealing in software. The agenda was 'how to form a tight relationship for the laser disc market to really take off'.

The hardware companies were Sony Australia, Pioneer Electronics, Yamaha, Philips, Mitsubishi, Samsung and Sharp, and the software firms made up of Polygram, Sony Music, Warner Music Vision, Capital Media and Columbia TriStar Hoyts Home Video. For all of these firms, 'laser disc' should be read as 'PAL laser disc'.

I saw my first laser disc player at Canberra's National Film Archives in 1981. The player — by Pioneer — cost $2500. The disc we watched was *Casanova*, pressed by MCA; it had cost US$15.95. At the time it was estimated there were two dozen machines in the country.

Both the player and the disc were NTSC products, and since then many of both have been quietly imported into Australia. Mainly by movie and video enthusiasts on their own initiative, because until now there has been al-



Pioneer believes the NTSC cause was furthered by 'the very early appearance of Total Recall on disc last year'.



most no marketing. (Some would say there still isn't.)

Some background

So what is a laser disc? The original patents are held by Philips, who developed the basic system around 1972. The basic technical standards were developed by Philips and MCA in late 1974, and players and discs were first marketed in the USA in 1978. The technology is allied to that of CDs and CD-ROMs, which were in fact a development from video laser disc technology.

In simple terms, the disc is a 30cm plastic platter carrying a concentric spiral of minute imbedded pits or craters. These craters constitute information which can reproduce vision and sound — a feature movie, a music video or whatever. A low power laser beam is bounced off the series of tiny depressions and the output sent to the TV set as video and audio signals.

The quality of vision and sound is superior to VHS tapes — which makes LD's currently the optimum way to watch a pre-recorded movie at home. Unless you've got a home 35mm theatre and a brace of cinema release prints!

Across the country you can now buy players (in PAL, NTSC or multi-compatible) from a number of manufacturers (Sony, Pioneer, Philips and Yamaha among them) and software of an appealingly varied nature. But before you step out your front door on a buying mission you must face the big decision: NTSC or PAL?

US buying clubs

In the US, Columbia House of Indiana run a club offering laser discs by mail. The enticement to join is an offer to 'Buy three for $1 each' — and commit yourself to purchasing two more (at US$29.95 each) throughout the ensuing year.

A bargain? By my book, yes. Especially when you scan the list of titles: *ET*, *Back to the Future III*, *Doctor Zhivago* and similar titles.

The only problem for an Australian resident is that these refreshingly current and attractively priced titles have been pressed in NTSC format. Which means you have to buy an NTSC-compatible player and hook it to an NTSC-compatible TV set, to view your impressive software.

No problems: you can buy NTSC players (starting at around $700) and NTSC-compatible sets (starting around $1200). But unfortunately, if you do take this path to enjoy LD's you are settling into an NTSC way of looking at the world — with 525 lines, lower definition and poorer colour than PAL presents.

This is the conundrum the PAL Laser Disc Association of Australia faced at their meeting last June.

NTSC software is abundant. Possibly no one person knows the total of titles available — probably many tens of thousands. There's little doubt in industry peoples' minds that the system will 'go' — but would it go if every potential LD enthusiast was faced with the hurdle of buying a new, NTSC-compatible TV before the fun could begin?

Gordon Bobbin, MD of Columbia Tristar, is well aware that there are new sets available which can accept an NTSC signal. But he pointed out that the average age of the TV sitting in a typical Australian home is 12.5 years. He believes that if people are reluctant to replace their fridge in this time span, they won't replace the telly.

It was due to the efforts of major players like Sony and Pioneer that we are now seeing a drive to get LD's moving, and Bobbin has played an important part in these decisions. He admitted, though, there have been a number of 'ill-fated starts' in the process.

"But on this occasion it was at the driving of Columbia Tristar — for two

Laser Discs: The Video 'Sleeper'



Nine million dollars are required to set up a laser disc factory. A disc can be pressed every 20 seconds.

reasons. The first was that we are now a Sony company with a natural association between the hardware and software sides of our business. And Sony — like six other companies throughout the world producing laser disc players, as marketers of a strictly playback system — needed software."

The group decision to 'go PAL' was because of the high proliferation of NTSC laser discs in the country. Bobbin also explained that because of seasonal movie release patterns in the US and Europe, LD titles were sometimes available two or three weeks before the cinema release — and in the majority of cases were available two to four months before release on videotape. But he commented:

"More importantly, we feel that PAL is of far superior quality. It made sense in our totally PAL market. People can purchase a PAL laser player or a multi-standard, take it home, plug it into a power point, connect to the set and press PLAY. With an NTSC player it meant a great catch-up period until NTSC-compatible TV sets were more common. We basically want to ensure that this PAL territory continues to be PAL territory."

At the present you can stroll through any major electrical retailer and not see an LD player. Distribution is still minimal. But Bobbin can remember the start of half-inch videotape in Australia — and it began exactly the same way.

"The hardware stockists who originally took on NTSC Betamax players originally didn't know which one (PAL or NTSC) would continue. But the benefit in half-inch tape taking off was that you could buy a machine and even if you didn't have a pre-recorded tape, you could still buy a blank tape and record off air — unlike a laser disc player, which is a playback only system, at this point."

Australian sales of players were expected to reach about 6000 players last year, with PAL and multi-format models accounting for around 2500. This would make the total current population run to approximately 10,000.

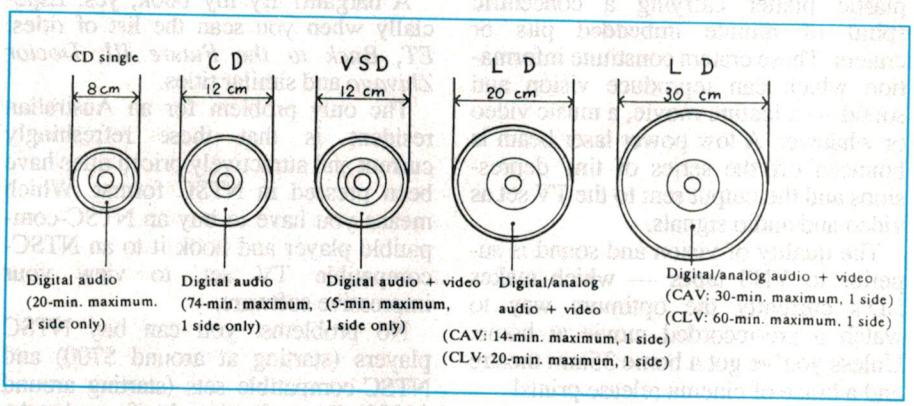
Pioneer

This company carries six models capable of NTSC replay, out of a total of nine. Paul Clarke of Pioneer justifies this by explaining that "NTSC titles are available months ahead of the PAL VHS movie being released, and sometimes even before the film is theatrically released at the picture theatre!"

He allowed that the software companies reacted quickly to NTSC imports — "certainly, spurred on by the very early appearance of *Total Recall* on disc last year".

While believing that the PAL product should be promoted because of the existing set population, he cautions that there is a 'videophile' market, which will still demand NTSC discs — purchased direct.

For these people the company can provide NTSC and PAL/NTSC players. As Clarke saw it, the long-running 'stand off' between hardware and software was not helped by the hardware companies blaming the software companies for the



Multi-disc players can handle five different sized discs — including audio CD's and LD's.

lack of inventory — and vice versa. As he called it, it's a real 'chicken and egg' situation.

Matters could be helped, he suggested, by software companies who have committed themselves to the PAL format taking it further and actually releasing and marketing titles.

Copyright worries?

There is some unhappiness (to put it mildly) that NTSC laser disc releases of new movies could reach our shores before the cinema prints are screened. This is obviously a significant problem for Sony — who own Columbia Pictures.

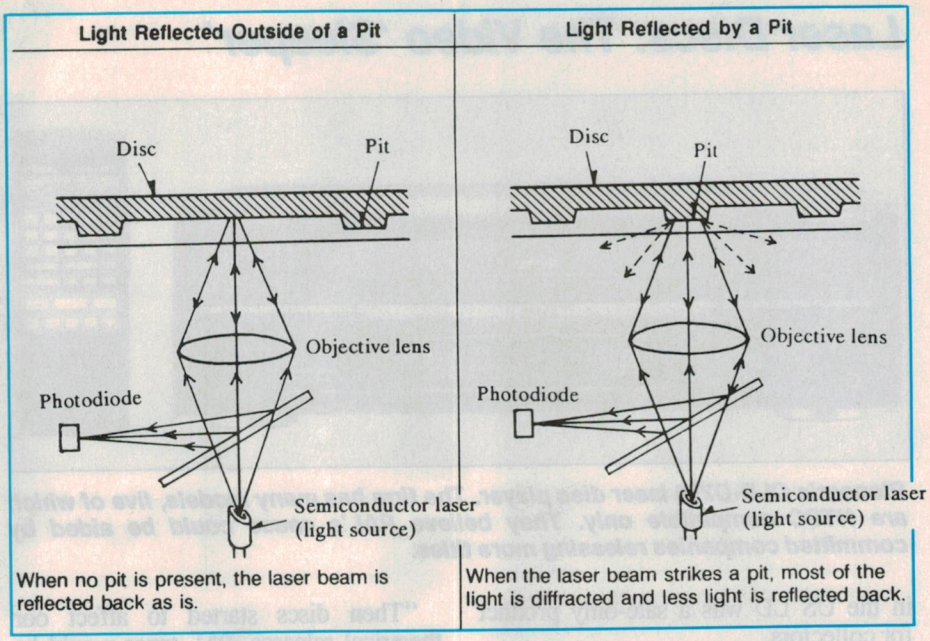
The association would like to see the laws of copyright enforced so that local retailers would not be able to sell US titles, unless licensed.

Says Bobbin: "Despite what some people may tell you, the rights of a title are retained by Columbia Pictures and their appointed agent. We are the operation in Australia. I'm a little annoyed that people have taken upon themselves to import NTSC product, to trade in that product without any thought or commitment back to the original copyright holder".

"There is an intellectual copyright that should be maintained and respected — i.e., that the rights of the writers, producers and other people are respected. The law will be used to stop that situation. I'm talking of dealers. The individual is another conversation altogether."

PAL product

At the time of writing, Columbia TriStar have just over 90 PAL feature titles in their current catalogue. Industry-wide there are probably close to 600 — including features, 'how to' training videos, classical and popular music videos, etc. Columbia TriStar are currently releasing around eight or nine new movie titles a month.



How the player's laser reads the disc.

Some retailers feel this is not enough. Len Wallis operates a highly-respected hifi shop in Sydney's Lane Cove. He has sold a number of PAL players, only to have them returned — the customers complaining of a software drought. With the formation of the PAL association, he feels "we may have shot ourselves in the foot". He also reads the European push to PAL LD's as 'back-pedalling'.

Another problem is that movies on PAL LD's currently cost around $115 in Australia, much more than either VHS tapes or NTSC discs.

Digital masters

Early NTSC LD's were mastered from 3/4" analog U-Matic tapes. Some still are, and this is reflected in the quality of reproduction.

But Bobbin says "We won't release a title unless we can get a D2 digital master. Some are using 3/4" masters — so you have this perfect delivery system taken from an inferior source".

"We transfer from an internegative, via a 625-line telecine, and have had to say 'no' to some titles that would make sense to release. Right at the moment we're having trouble getting a copy of *Lawrence of Arabia* — the extended version, the 'Director's cut' in a D2 digital master."

PAL vs NTSC titles

TriStar admit they could bring in probably 400 titles 'next month'. However, this makes no economic sense, as Bobbin points out:

"The economics of my bringing in 400 titles next month — the cost of the master, the cost of replication, the cost of importing is one thing. But I know they're going to sit in our warehouse, because even though there are all these people saying 'when are we going to have as many PAL as NTSC titles?', they couldn't afford to buy them. More importantly, the consumer couldn't afford to spend the time to watch them!"

Overseas growth

As yet the main growth of LD has been in the USA and Japan — the number of players sold has doubled over this year. Helping this is the fact that the video players are CD audio compatible.

Discs have not overtaken VHS tapes in either the US or Japan. In the US, there's probably a maximum penetration of 8%, helped by a massive drive in the 'sell-through' market. Originally,

Laser Disc Technology: A Summary

A Multi Disc Player (MDP) is capable of playing CD's (8&12cm), VSDs (video single discs — 12cm), 20cm LD's (laser discs) and the 30cm LD's. Many can also play 12cm CD-V (CD-video) discs.

CAV (constant angular velocity) laser discs rotate at a constant 1800rpm. Each track contains one frame of vision. One side of a 30cm CAV disc holds 30 minutes or 54,000 frames.

CLV (constant linear velocity) laser discs rotate at various rates, depending on whether the track being read is near the centre of the disc or the outer edge. Being inside start, the inner tracks are read at 1800 rpm; the outer tracks are read at 600rpm. Playing time for these 'extended play' discs is up to 60 minutes per side.

Capabilities: unless the disc player is equipped with a digital frame store, only the CAV 'standard play' disc can be played in still frame, slow and various 'trick' modes.

(The above figures relate to NTSC. With PAL discs, a CAV 'active play' disc rotates at a fixed 1500rpm, and a 30cm disc plays for up to 36 minutes per side. A CLV 'long play' disc varies between 1500 and 570rpm, and a 30cm disc plays for up to 60 minutes per side.)

Laser Discs: The Video 'Sleeper'



Pioneer's CLD-D750 laser disc player. The firm has many models, five of which are NTSC compatible only. They believe PAL's cause could be aided by committed companies releasing more titles.

in the US LD was a sale-only product for collectors.

Bobbin says: "Now it's an opportunity for rental companies to go to a K-Mart or Tower records outlet and buy, say, 10 discs for $24 each, then rent them for $4 overnight — for the rest of time. Remember that unlike a tape, the disc won't wear out".

Bobbin's company had a very healthy PAL market in Hong Kong. Then, Bobbin admits: "Slowly but surely, the proliferation of NTSC machines into that free-tax port meant that every yuppy businessman was going out and buying a laser disc player, paying $249 - 299 maximum, for a top of the range NTSC model".

"The discs, of course, were on sale 48 hours after release in Tokyo and Los Angeles. So, more and more, the video stores started to swing over to NTSC discs because of that release pattern — because the PAL tape was not yet on release. Because of the competition, we saw in the space of about 18 months the market go from a fairly healthy one to less than 10%. NTSC discs killed the rental of PAL tapes."

"Then discs started to affect our theatrical releases. PAL tapes would be released 3 - 4 months after a movie, but the laser disc often arrived immediately after cinema release. We lost two or three major releases theatrically because, on our best information, there were about 6000 - 7000 discs already in the territory."

(One could question the company's wisdom in permitting such an early release of the titles on disc in the first place! If they can prevent early release on videotape and PAL disc, it's hard to see why this can't be done for NTSC discs as well...)

Piracy potential

The downside of LDs for the software companies is that they make perfect dubbing masters. All a software pirate needs to establish a profitable — although highly illegal operation — is to set up an LD player, a collection of discs and a VCR.

However, the actual pressing of pirate LDs is not of great concern: the cost of setting up a plant approaches $9 million!

In PAL, it is considered there are only three or four suitable plants worldwide. Both Sony and Pioneer have plants in Japan, and the latter operates another in Long Beach, California. Columbia TriStar use the DADC facility in Austria — a Sony-based plant.

Technical problems

A Yamaha executive revealed that some retailers are finding the multi players are unable to display a signal on some sets, when playing an NTSC disc in PAL mode.

The 'cheating chip' which tricks the set into believing it is a PAL signal sometimes does not work. The company believes it is better to stay in NTSC because of the size of the library — 63,000 titles was his estimate. Another industry figure discounted this by saying "there was a problem with early NTSC machines not adapting to the newer pressings."

There's another technical problem too, concerning display aspect ratio.

Movies in Edison's time were 3:4 in aspect ratio (height/width). Ironically, the aggressive growth of television in the 1950's saw the cinema introduce wide-format movies as a countermeasure to falling attendance figures — and so created a problem for today's TV and video replay.

Cinemascope and Panavision have 2.35:1 ratios. As a movie director, you may desire to place Tom Hanks on left of screen, balling out Madonna on the right. But run the same scene on the video screen, and you are given two choices.

You can either 'Pan and Scan' the footage, giving the 3 x 4 screen to separate closeups of each player, or 'Letterbox' the scene — placing black masks at top and bottom, and allowing the wide image to spread across the screen, albeit in diminished size.

It's likely that we're going to see LD's given initial release as 'Pan and Scan' versions, for the mainstream PAL market. Then, six months later, selected titles could be released as connoisseur's versions — in 'Letterbox' format. In the US these versions often carry 'behind the scenes' footage and interviews with the director, along with multiple channel audio.

This may have some validity, as we all sit down to watch our 12.5-year old TVs. After all, how much would you extract from some of the desert scenes in *Lawrence of Arabia* — on a 50cm screen two or three metres away? ❖



Yamaha's CDV-1700 laser disc player, which plays all five standard disc formats.

Insiders say Sculley often embraces as his own the ideas of many of the top Apple engineers and programmers who have his ear — leading some observers to say Sculley shouldn't get credit for divining the future of the industry.

"You don't have to be a rocket scientist to see these trends," said Pieter Hartsook, a Macintosh newsletter publisher in Alameda. "I wouldn't say Sculley is a visionary. He's very good at seeing where the market is going and what the company needs to do to be in the right place at the right time with the products it needs."

Outsider to futurist

But most outsiders who know Sculley say he has gone from technology observer, through technology student (he once had a technical assistant called 'Tutor to the President') to futurist. Along the way, in 1987, he outlined a 21st century portable personal computer called the 'Knowledge Navigator' that provided its owner with a wealth of information access and communications controlled by speech and touch. Newton is the first tangible evidence that Sculley and Apple are on the road to creating it.

"When Sculley came in, he was by no means a technologist, nor by any means a futurist," said Tim Bajarin, a Santa Clara industry analyst who often acts as a consultant to Apple. "Between 1984 and 1987, none of what he said was original; he was saying what everybody else told him to say. But when he spoke at the end of a multimedia conference two weeks ago, those were some of the most original visions I ever heard."

Apple's top technologists insist the 53 year old Sculley — a tall, lanky and shy man with a degree in architecture and an MBA — is surprisingly astute about computing technology. They say he understands not only what is technically feasible to design and what isn't, but more importantly, sees how the technology will ultimately affect consumers.

"Sculley is incredible", said Rick LeFaivre, director of software technologies in Apple's Advanced Technology Group (ATG), which Sculley oversees. "He reads technical information, not just executive summaries, and has a great capacity to absorb information."

But when he arrived at Apple, Sculley was considered "an empty suit who could play power politics with Jobs," Kass said. And Sculley admits that shaking that image has proved difficult.

Apple changing

"When I took on the job (of chief technical officer) a lot of people didn't think it was a good idea," Sculley said in an interview at his modest Cupertino office, neatly lined with knick-knacks, a pair of hot pink Converse All-Star sneakers, three computers and an interactive television game unit. "When I first wrote about the Knowledge Navigator five years ago, people thought it was either marketing hype or a kooky idea."

A scant six months ago, many Apple employees still felt that way, and would rather have hurled rocks at Sculley than praise.



A display sample of Apple's Newton — the first of its new family of 'personal digital assistant' products.

Last year, Apple abandoned its traditional strategy of selling products at margins fat even for the lucrative computer industry, and concentrated instead on gaining market share with inexpensive models. But slimmer margins coupled with the recession meant a painful reorganisation of Apple that led to 1000 lay-offs last year, with a threat of hundreds more, and the cancellation of some pet projects.

Pay levels, once in the top 10% of the computer industry, were cut back to the top 25%, and middle managers cut little perks like free pinball machines and soft drinks that employees had long taken for granted.

Most galling of all, to many staffers, was the startling alliance Sculley masterminded in 1991 between Apple and IBM — a deal that involved sharing jealously-guarded Apple technology with a company many employees regarded as the enemy. To top it off, they knew that Sculley was getting ready to publicly discuss the company's commitment to PDA's. Sculley, with a reputation inside Apple for constantly changing direction — some call his management style 'strategy *du jour*' — believed his latest obsession would take the spotlight off the Macintosh at a crucial time.

Huge salary

Emotions erupted at Apple's regular communications meeting with several hundred workers last October, when bitter employees complained angrily to Sculley that they saw no reward for the gruelling hours of work that swallowed their personal lives.

They especially complained that, while their salaries were being cut, Sculley continued to enjoy huge remuneration. That's a particularly sensitive issue with Sculley, who got a US$1 million salary and US$1 million bonus for joining Apple, and consistently tops the list of Silicon Valley's best compensated executives. In 1991, Sculley's salary and bonuses alone were worth well over US$1.3 million, and he continues to gain lucrative Apple stock options.

In his first eight years at the company, his options were worth a total of US$14.6 million. And last year, Sculley fired off a lengthy letter defending his compensation as "below the national average for CEO's running $6 billion companies."

But when employees complained about their pay, Sculley told them to get used to it: the computer industry was undergoing a fundamental shift, he said and would 'never again be the same' as it was in the 1980's.

"The industry today is like the steel industry — a commodity industry," he said. "Apple can be a good player in such an industry, but it requires that Apple run its business very differently than in the 1980's. We still believe in empowerment, but that means entitlement and sponsorship of whatever you do."

Some insiders say that with a wrenching change in work environment and a big push into the new, untested world of PDA's, the backlash was natural.

"How do you take a company where most people came in with a passion for one thing — playing with the Macintosh — and make them have a passion for things that aren't the Mac?" said Chris Espinosa, a 16-year Apple veteran.

Apple's Sculley

Weak communicator

Compounding the problem is Sculley's personality. He's uncharismatic, especially in comparison with Jobs — "He's like a fish out of water; his eyes go blank when you talk to him," analyst Kass said. He wears glasses to read, but is self-conscious about them and doesn't like to be photographed with them on. And he's more comfortable speaking from prepared notes.

Sculley has even read from a television monitor when speaking to employees at communications meetings — which are intended to foster informal and frank discussions.

"Flamboyant and Sculley are not used in the same sentence", Espinosa said. "He is not as successful at getting people to believe in the things he believes in, as Steve Jobs or Microsoft chairman Bill Gates. But he *can* take outlandish ideas and make them sound successful."

Today, though, many employees have reconsidered their opinions of Sculley. He's turned them around, in part by steadily plugging away at his vision of computing devices of the next century, and turning his top technicians loose to create — from scratch — the individual pieces that will some day make up the Knowledge Navigator. Under Sculley, they are developing software that can recognise human speech; control the computer with a flick of an electronic pen or understand letters printed with it; and manipulate three dimensional images and video clips.

Intends Apple to lead

Sculley constantly talks about wireless data communications as the most crucial element of PDA's, and has launched projects to develop the technology as well as dispatching senior vice president and ATG director David Nagel to Washington, DC, to lobby the Federal Communications Commission to modify its policies to favour data transmission via radio.

"I never defined the (chief technical officer) job as being only media and publishing consumer electronics and entertainment. Every part of that convergence involves digital computer technology", he said. "And the overall market will, by the turn of the century, be worth US$3.5 trillion, rather than the US$80 billion the computer business is worth today."

"Our goal," he said, "is to be nothing less than the leader in the world in this mega-industry."

Then he points to another chart that shows software giant Microsoft has a market value nearly three times Apple's US$7 billion — yet had just 29% of Apple's US$6.3 billion revenue in 1991. The difference, Sculley said, is that Microsoft successfully controls a vital layer of technology — MS-DOS — and declared Apple must do the same by becoming a 'hybrid' company that treats the PDA business quite differently from the Macintosh business.

"The big payoff is not in selling devices," although Apple will sell some in order to 'jump start' the market, Sculley said. The real profit, he noted, is in selling the software, the chip designs and other 'layers' of technology that make PDA's possible. "Apple gets categorised as a hardware company, but all the investment in research is in software", he said.

"Sculley is starting to turn us into the Apple Computer company, not the Macintosh Company", Espinosa said. "We're getting back to where we were in 1980 and 1981, when we had one line of business doing very well and we know would continue, but also knowing that it couldn't keep us going and competitive forever. We know there is other technology it's necessary to exploit for the corporation to carry on into the late 1990's."

The rest of the computer industry appears to have heard Sculley. A mere month after Sculley first used the term 'personal digital assistant' in a seminal keynote speech at the Consumer Electronics Show in Las Vegas last January, Microsoft chairman Gates used the same term and outlined the same target market in a San Francisco speech.

But company observers say Apple faces many hurdles in this new market, even if it successfully develops the technology layers Sculley wants.

First of all, analysts said, he must keep the company's house in order, and continue to grow its core personal computer business — and their profits — in order to support the fledgling PDA business. That means continuing to produce the 'hit products' Sculley talks about in public forums — something analysts say will be difficult to do.

Japanese links crucial

Sculley must also correctly structure the new PDA business, which has radically different customers, products, profit margins and distribution channels than do personal computers. The most difficult challenge may be managing Apple's utter dependence on corporate partnerships with giant Japanese companies like Sharp and Sony to manufacture PDA's.

Apple has never managed such partnerships well. A much publicised deal with Digital Equipment in 1987 resulted in few products and little benefit to Apple. Its deal with IBM, too, hasn't gone smoothly. For almost seven months after the deal was signed, a joint venture called Kaleida, which will develop 'multimedia' software standards crucial to PDA's, was stalled with no top management...

Said analyst Kass: "Their future is so tied to delicate relationships with Japanese companies which are far bigger and more powerful, that any blip would dramatically affect their ability to compete."

Sculley said Apple has no choice but to seek out those partners, though. "We need the drive and component competencies the Japanese companies have in things like screen technology and storage technology. And we need to have relationships in the media industry — in Hollywood", he said. "In the computer industry today, it's a relationship industry."

Offloaded operations

"The biggest challenge is to recast the company into smaller autonomous teams that can chart off in new directions — but directions that can complement other ones while still being different", said Charlie Oppenheimer, director of Macintosh System Software marketing.

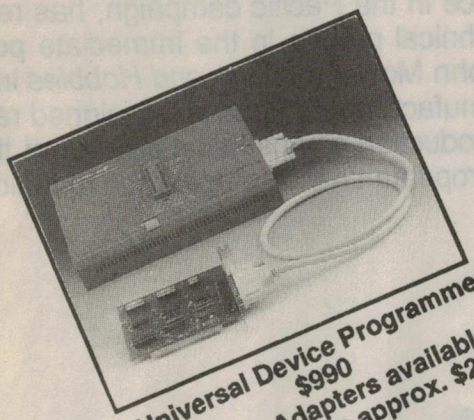
To that end, Sculley has turned the burden of day-to-day operations, and the development of the office computer business, over to company president Michael Spindler. Along with Sculley, Spindler has managed to dramatically reduce the time it takes Apple to get products from the drawing board to the marketplace, from two or three years to a few months in some cases.

That's led to a string of successful products, most notably the PowerBook notebook computers, which the company must have in order to earn enough money to fund the ambitious expansion into PDA's.

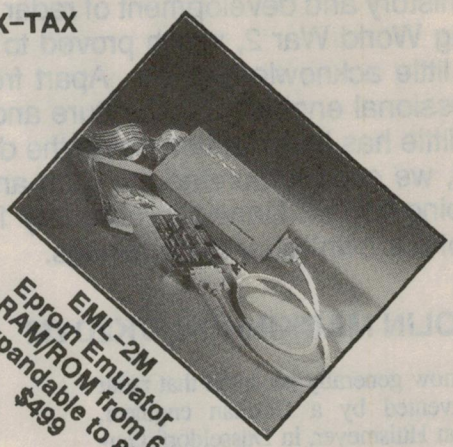
People inside the company as well as analysts credit Spindler, a pragmatic German whose earthy charisma makes up for what Sculley lacks, with freeing Sculley to pay far more attention to the PDA business. "All the things we have to do (to remain competitive) have been Spindler's doing", Espinosa said. "He is setting up the company for John's projects to fit into. If John had to do it himself, he'd have no time for anything else." ❖

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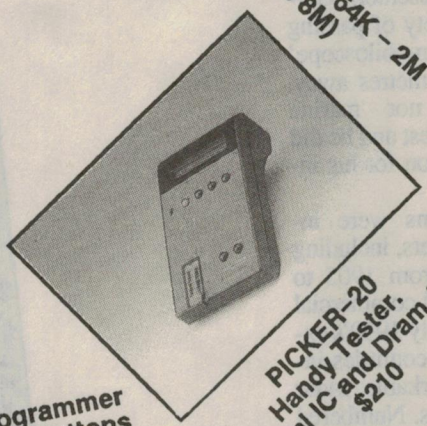
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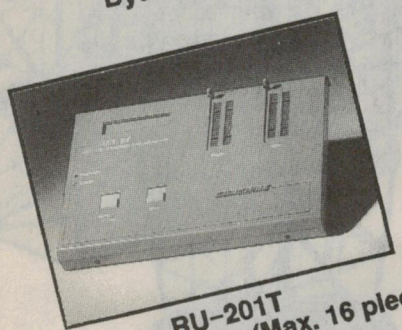
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The early history of Australia's Radar - 1

The history and development of radar in other countries is well documented, but the Australian effort during World War 2, which proved to be of vital importance in the Pacific campaign, has received very little acknowledgement. Apart from two or three technical papers in the immediate post-war professional engineering literature and three articles by John Moyle in *Radio and Hobbies* in 1946, very little has been written about the development and manufacture of Australian-designed radar. In 1992, we commemorated the 50th anniversary of the introduction of Australian radar and the first bombing raid on Darwin in February 1942, so it is an appropriate time to present the technical history of our own radar undertakings.

by COLIN MACKINNON, VK2DYM

It is now generally accepted that radar was invented by a German engineer, Christian Hülsmeyer, in Düsseldorf, Germany in 1904 with the safety of passing ships in mind. His 'Telemobiloscope' detected ships up to 3000 metres away, but neither the Navy nor marine authorities showed any interest and he did not receive proper recognition for his invention until 1955.

Various radar-like systems were invented and promoted by others, including Marconi, over the period from 1905 to 1935 but none really showed commercial promise. However, in the early 1930's experimenters in a number of countries independently developed workable radar systems for military purposes. Numbered among those countries which by 1939 had significant radar developments were the United Kingdom, USA, Germany, Russia, Japan, France, Italy, Holland and Hungary. Because of the defence connotations much of the research was done in secret and isolation, but surprisingly the concepts and the resultant equipment in each country were quite similar.

One significant omission from this list of countries with radar capacity is Australia — despite the fact that it had a strong radio/electronics research group, under the auspices of the Radio Research Board (RRB). With the introduction of commercial broadcasting to Australia in 1923, it was found that radio waves acted in strange and unknown ways and so the RRB was established in 1926 as a unit of the Council for Scientific & Industrial Research (CSIR), to investigate radio propagation and other matters arising from the application of radio. Members of the RRB included the Universities of Sydney and Melbourne,



Fig.4: A rare photo of an ShD antenna mounted on a concrete building. The hydraulic rotation apparatus is in the steel clad frame supporting the array. The massive construction was necessary to withstand coastal storms.

How did World War II radar work?

The radar set of WW2 consisted of a powerful radio transmitter which sent out short pulses of radio waves via a directional antenna. When these radio waves struck any metal objects in their path, some of the energy was reflected back to the antenna. This minute echo or 'return signal' was amplified in a sensitive receiver and then displayed on a cathode-ray tube, as a vertical 'blip' on a trace moving from left to right.

As in an oscilloscope, the horizontal scanning of the CRT trace was arranged to be linear with time. Since radio waves travel at around 186,000 miles per second (300km/s), the time taken before the return signal pulse was received gave a direct indication of the distance to the target. A scale graduated in terms of distance could therefore be placed over the CRT, allowing the target distance to be read off directly from the horizontal position of the received 'blip'.

It all sounds very simple in theory, but the engineering problems back in the 1930's and early 1940's were daunting. A great deal of research and testing was required before a workable system was achieved.

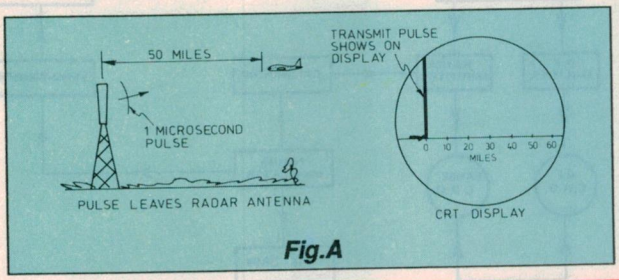


Fig.A

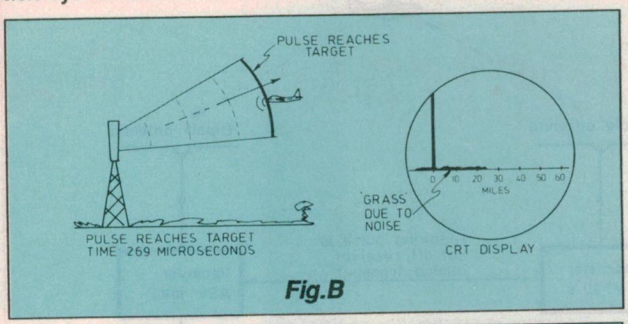


Fig.B

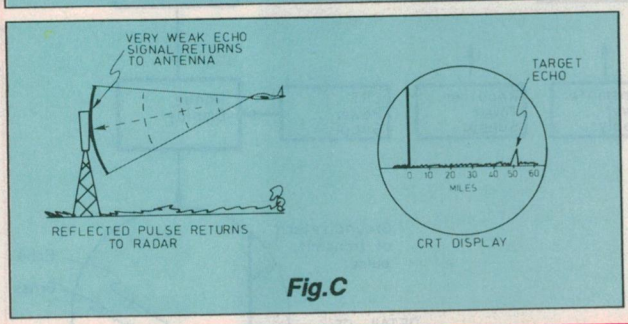


Fig.C

the PMG's Department and the Department of Defence.

By 1936, the universities had well established laboratories and field stations and were carrying out ionospheric sounding using continuous wave and pulse transmitters to probe the atmosphere and record the returning echoes. An ionospheric sounder comprises a transmitter which sends out a radio wave via an antenna, vertically into the atmosphere. An accompanying receiver measures the echo, and the time delay between transmission and reception is an indication of the height of any reflecting layer in the ionosphere.

Had they but realised, the ionospheric researchers had within their grasp the building blocks of a practical radar set; but it appears that no-one in Australia even considered the possibility of obtaining echoes from target objects.

One might well have expected the defence forces to ask about the possibility of using radio echoes for locating enemy ships, but it seems that there was no such vision. The perception of radar only became evident to Australian scientists when one or two visited the UK in the mid-1930's, and became aware of secret research being carried out by their colleagues, using radio pulses for locating targets.

Even when this was communicated back to the RRB in late 1938 by Dr John Piddington, an Australian scientist who had been studying in England and working on aircraft location by radio direction finding, no interest was shown. The significance of this total lack of radar research in Australia will become evident as we follow the story of Australian radar.

Early research

In February 1939 Australia, along with other Commonwealth countries — namely Canada, New Zealand and South Africa — was invited to England to learn 'of a matter of the utmost secrecy involving radio': the secrets of British radar, or as then known, Radio Location. It was logical that the CSIR should be involved because of its expertise in radio research, and when the importance of the British revelations became clear it was decided to establish a Radiophysics Laboratory (RPL) within the CSIR, to carry out research and development of radar under British guidance. The name 'Radiophysics' was chosen to minimise suspicion as to the true purpose of the laboratory, which was set up in the National Standards Laboratory building at Sydney University.

Following consultation between the UK and Australian representatives, the first projects for the new research laboratory were to be:

1. 'ShD' or Shore Defence radar (sometimes also called 'CD', for Coastal Defence);
2. 'GL' or Gun Laying radar (i.e., to assist anti-aircraft gunnery); and
3. 'ASV' or Air to Surface Vessel radar.

Government and defence thinking at the time was that Australia had little to fear from air attack and therefore could concentrate on ShD equipment to safeguard its shores from warships, with ASV radar to permit our aircraft to find enemy ships. GL equipment would be used with anti-aircraft guns to counter the slight possibility of nuisance air attacks.

The emphasis for the RPL was on research, to assist the UK by developing and testing new radar equipment and deriving a better understanding of the techniques involved. The initial intention was for Australia's few radar equipment needs to be supplied from the UK, with some local design and assembly.

While Australian scientists were in England in 1939 to learn about the UK radars, they did order samples of UK radar equipment. By this time the UK radar warning system, the 'CH' or Chain Home system was in operation on frequencies around 25MHz, and development was proceeding on smaller and transportable sets that could fill the gaps in the CH system. These included the CHL, for Chain Home Low, a 200MHz fixed radar with a rotating antenna array suitable for long range detection of low flying aircraft, and the MB2 or Mobile Base Mark 2, a 40MHz semi-portable version of the CH radar using two tall wooden towers with fixed dipoles and capable of long range warning of high flying aircraft. Australia ordered samples of each of these, as well as some ASV and GL radar sets, but Britain was only able to supply a few of them due to the onset of the war in Europe.

The Radiophysics GL and ASV projects proceeded as far as the prototype stage, but were failures because they of-

The early history of Australia's Radar - 1

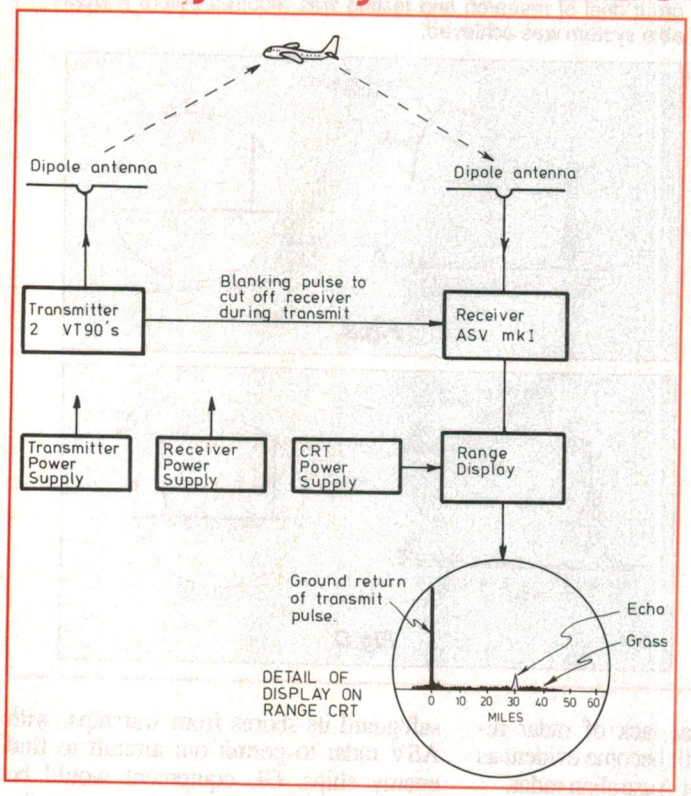


Fig.1: A block diagram of the first radar set developed in Australia by the RPL team, in May 1940. Called the J2, it used two separate antennas and was based on the British ASV.

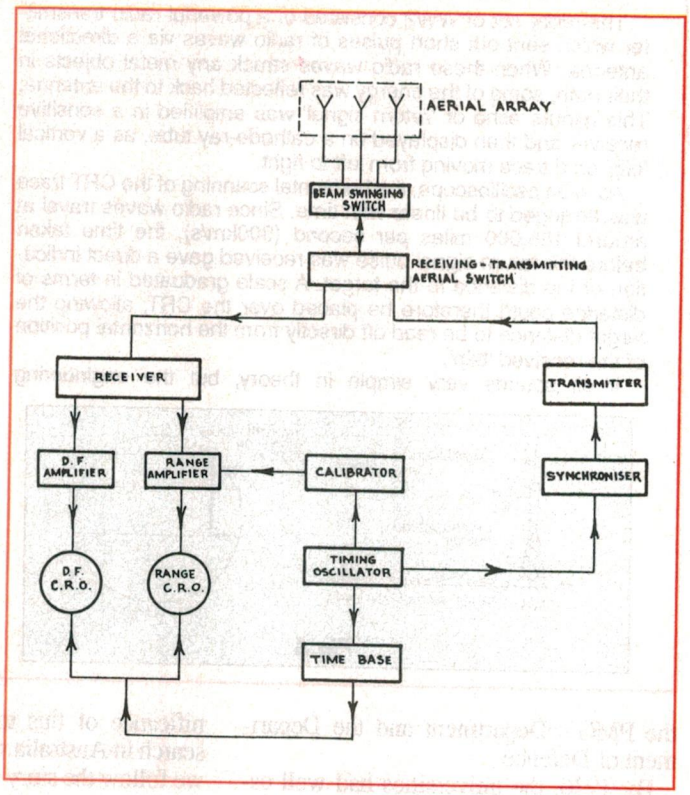


Fig.2: For comparison, here is the block diagram of the complete 'ShD' or Shore Defence radar. This was based on the J3 prototype, which evolved in early 1941.

fered no better performance than the original UK models and were eventually abandoned in favour of improved UK equipment. Local manufacture of a copy of the UK ASV MK II did commence later in 1941, but was contracted out to the Gramophone Company, part of EMI.

The ShD project proceeded satisfactorily, although very slowly. The RPL did not seem to have a sense of urgency — no doubt influenced by the prevailing notion that Australia was safe due to its isolation. The military advisers and the government were happily telling the population that Australia was under no threat. Despite the fact that the military establishment was represented on the Radio Advisory Board, a body which had been set up to guide the RPL, the defence forces showed little enthusiasm and at higher levels there was a great lack of technical understanding of radar.

The actual work was in the hands of young scientists, some with very little electrical knowledge and more used to unhurried experiments using one-off test equipment in a cloistered environment. We should also keep in mind that the entire scheme had the highest security classification ('Most Secret'), and this stress on total secrecy bordered almost on paranoia.

It meant that only Government departments could be trusted with the manufacture of radar components. Therefore the PMG's Department and the NSW Government Railways carried out the bulk of the manufacture at this stage.

First steps

Because no-one in Australia had any practical experience with the operation of radar, the initial RPL effort centred on construction of a working set to gain experience in the techniques and operation of radar. RPL technicians built and tested several simple transmitter and receiver circuits, which essentially repeated previous experiments by an English research team working on airborne radar back in 1937-38 under the leadership of Dr E.G. 'Taffy' Bowen.

This early work by RPL from late 1939 to mid-1940 provided them with much needed experience in electronics and RF circuitry. Frequent reference was made to the ARRL amateur radio handbook, as RPL staff struggled to become RF designers.

By May 1940 a radar set designated the J2, based on a sample of the UK ASV Mark I, was installed in a research station at Dover Heights on Sydney's coastline. It incorporated a push-pull oscillator with two newly-developed valves called the VT90 or 'micropup', giving a pulse output of about 4kW. The receiver was an ASV model imported from England, and it was initially housed in a separate hut.

The transmitter and receiver each had a single dipole aerial. A timebase, an oscilloscope display and other ancillary units were built by RPL to form a rudimentary radar set. This first full working set was able to detect ships and low-flying aircraft at a distance of up to six kilometres, but was obviously inadequate for practical use.

In July 1940, a complete ASV MkII transmitter also using VT90 valves, and a production version of the UK Pye ASV receiver was received from the UK and installed in the second hut at Dover Heights, to gain more operating experience in ship and aircraft detection. This ASV MkII radar operated on a revised frequency of 176MHz, whilst other UK and Australian ground radars were designed for 200MHz.

Trials of the J2 and the ASV continued until about September 1941. See Fig.1 for a diagram of the basic system.

The RPL scientists spent much time and effort improving the timebase of their radar, and it is important to understand the reasons. The ASV transmitter used what

is known as a 'squegging' oscillator circuit, wherein a small capacitor in the plate circuit is discharged until the grid bias voltage reduces to a point where the circuit breaks into oscillation. The resulting current flow re-charges the capacitor until it cuts off the grids and stops the oscillation. By adjusting the component values, the period of oscillation could be reduced to a few microseconds, with a pulse recurrent frequency or 'PRF' of about 500 pulses per second.

It is a simple system, and importantly for aircraft use, provides a lightweight design. However, circuit and valve tolerances caused random fluctuations in the output frequency, timing and PRF. This did not matter so much in the ASV role, where an aircraft picks up a return echo and then 'homes in' on the signal until the target is visible; an initial range error of a mile or two does not affect the result.

However in the proposed ShD role, the distance to the target had to be measured precisely — within just a few yards — to allow accurate gun laying. Consequently RPL changed their circuit to a more conventional RF oscillator driven by a modulator, with a very accurate timebase, so that the controlled pulse width and PRF guaranteed accurate range reading.

A working prototype

In January 1941, following on from the work with the J2 and the ASV MkII, an improved radar set design was installed at a second field station at Brookvale, north of Sydney. This set, called the J3, was again based on the UK ASV MkII design but included a locally designed synchroniser with the improved timebase, and other ancillary electronics.

The receiver was modelled on the ASV MkI, after trials with alternate receiver designs showed no advantages. The antenna was a 16-element phased array and RPL had by now developed a method of using one antenna for both transmit and receive.

This radar was operated under field trial conditions by RPL and Army technicians through to September 1941. At this stage the emphasis was still on Shore Defence and Gun Laying, both of which required very accurate range finding but with a maximum range of only 40km. The J3 performed satisfactorily, despite a number of annoying failures due to the poor quality of locally made components, and formed the basis for the ShD and other radars that followed.

The J3 transmitter employed two VT90 'micropup' valves in a grid tuned, push-pull oscillator circuit with Lecher line tuning. Another Lecher line was loose-

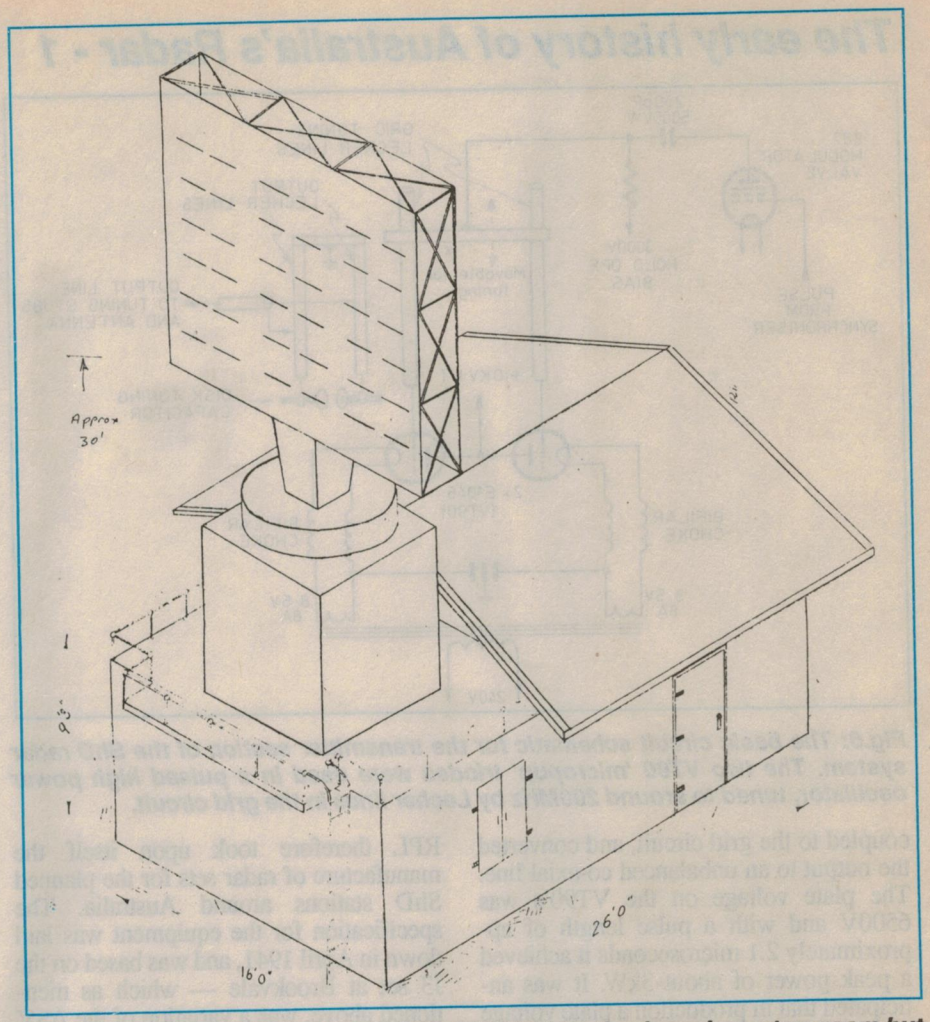


Fig.3: An original design sketch for an ShD installation based on a two room hut with the rotating antenna mounted on top. Compare this with the photo of Fig.4.

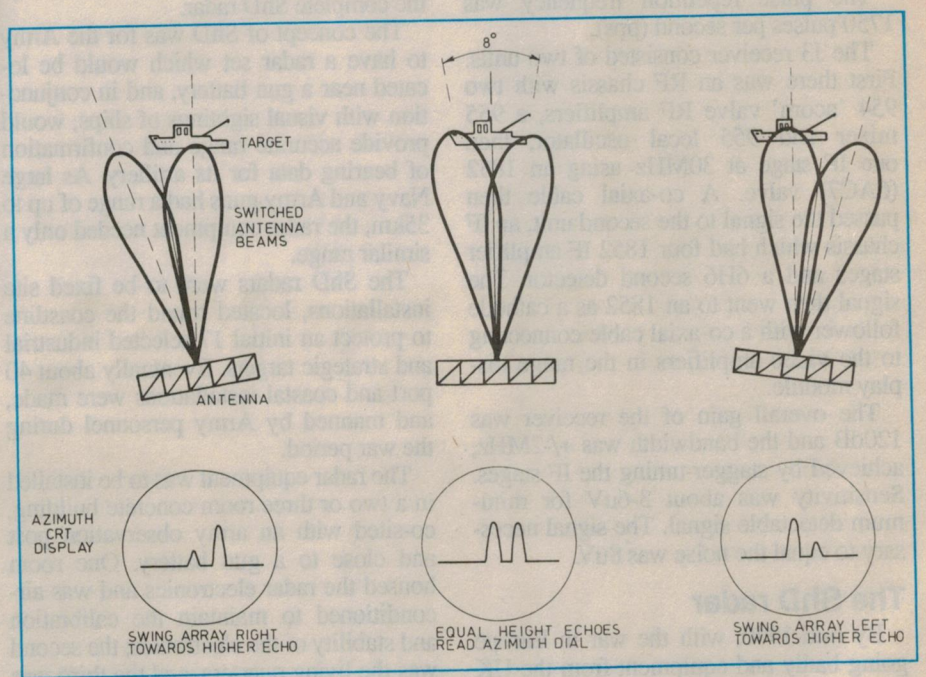


Fig.5: A diagram which illustrates the concept of 'beam swinging', which was used to provide greater accuracy in determining the azimuth bearing of a target. The correct setting was achieved when the two blips were of equal height.

The early history of Australia's Radar - 1

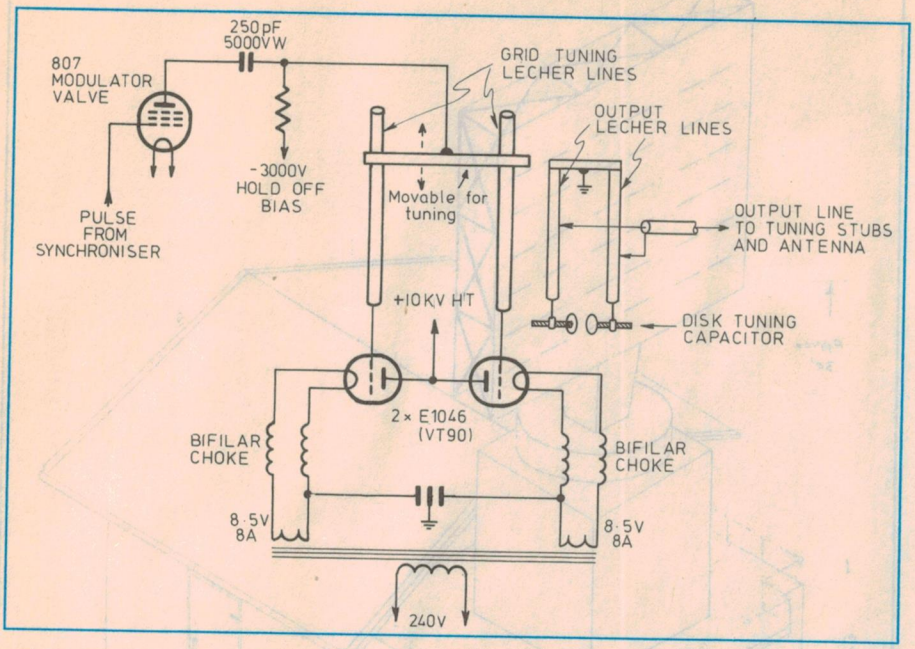


Fig.6: The basic circuit schematic for the transmitter section of the ShD radar system. The two VT90 'micropup' triodes were used in a pulsed high power oscillator, tuned to around 200MHz by Lecher lines in the grid circuit.

coupled to the grid circuit, and converted the output to an unbalanced co-axial line. The plate voltage on the VT90's was 6500V and with a pulse length of approximately 2.1 microseconds it achieved a peak power of about 3kW. It was anticipated that in production a plate voltage of 10,000V would be possible, to give a 10kW pulse.

The pulse repetition frequency was 1750 pulses per second (pps).

The J3 receiver consisted of two units. First there was an RF chassis with two 954 'acorn' valve RF amplifiers, a 955 mixer and 955 local oscillator, then one IF stage at 30MHz using an 1852 (6AC7) valve. A co-axial cable then passed the signal to the second unit, an IF chassis which had four 1852 IF amplifier stages and a 6H6 second detector. The signal then went to an 1852 as a cathode follower with a co-axial cable connecting to the video amplifiers in the range display module.

The overall gain of the receiver was 120dB and the bandwidth was +/-2MHz, achieved by stagger-tuning the IF stages. Sensitivity was about 3-6uV for minimum detectable signal. The signal necessary to equal the noise was 8uV.

The ShD radar

By mid-1940, with the war in Europe going badly and equipment from the UK simply unavailable, it was clear that Australia would have to become virtually self-sufficient in radar production. The RPL therefore took upon itself the manufacture of radar sets for the planned ShD stations around Australia. The specification for the equipment was laid down in April 1941, and was based on the J3 set at Brookvale — which as mentioned above, was a variation of the ASV MkII transmitter and ASV MkI receiver designs. See Fig.2 for a block diagram of the complete ShD radar.

The concept of ShD was for the Army to have a radar set which would be located near a gun battery, and in conjunction with visual sightings of ships, would provide accurate range and confirmation of bearing data for its artillery. As large Navy and Army guns had a range of up to 35km, the radar equipment needed only a similar range.

The ShD radars were to be fixed site installations, located round the coastline to protect an initial 17 selected industrial and strategic targets. Eventually about 40 port and coastal installations were made, and manned by Army personnel during the war period.

The radar equipment was to be installed in a two or three room concrete building, co-sited with an army observation post and close to a gun battery. One room housed the radar electronics and was air-conditioned to maintain the calibration and stability of the electronics; the second was the living quarters, and the third was an observation post, if one was not already available.

The large aerial array had to be about 80-90 metres above sea level, and in most cases a tower around 9m high was mounted on the roof of the building. But for low sites, for example at Darwin, a separate tower was constructed — either 55 or 70m high. The tower base was designed by a young NSW Railways engineer, Mr Ern Bullock, so that even if one leg was destroyed the other three would maintain support.

A separate engine house suitable for a 20kW Ford V8 engine/generator was also constructed, although diesel engine/alternators became the preferred power supply.

A number of these buildings still exist, around Australia's coastline. A typical two-room ShD radar hut is located on Hill 60 at Port Kembla, NSW, whilst about 1km north along the beach there are two gun emplacements for 150mm (6") guns, next to the Army Command Post building — which is now a military museum.

RPL specified and designed the buildings, in collaboration with the Department of the Interior, arranged subcontracts with other government departments and even assembled the first couple of ShD radar sets.

The PMG made cubicles and electronic assemblies while the Railways made antennas, turning mechanisms and other mechanical components. The PMG was responsible for sub-contracting out the construction of the antenna towers which had been designed by the NSW Government Railways. See Fig.3, a design sketch of the ShD installation, and Fig.4, a photo of an ShD installation.

The first three sets to meet the requirements for ShD were built by the RPL in prototype form and were known as the type CA No.1 MkI. With minor improvements and changes to simplify manufacture, this design became the CA No.1 MkII in full-scale production.

The aerial for the ShD set was a phased array of 36 elements (6 x 6) on an angle iron frame about 5.5m wide by 4m high, covered with a 25mm reflector mesh and weighing several hundred kilograms. It was designed to withstand coastal gales.

Originally the array was fed via 70-ohm co-axial cable, but this was soon replaced by 300-ohm open wire feeders which were easier to adjust for correct phasing. Aerials mounted on the 55m or 70m towers were connected via rigid 50mm diameter co-axial line.

To obtain accurate bearings on the target, a technique known as 'beam-swinging' was used. The aerial elements were connected in three side-by-side sections, and the feeders were arranged so that extra capacitance could be switched into line between the outer two sections at

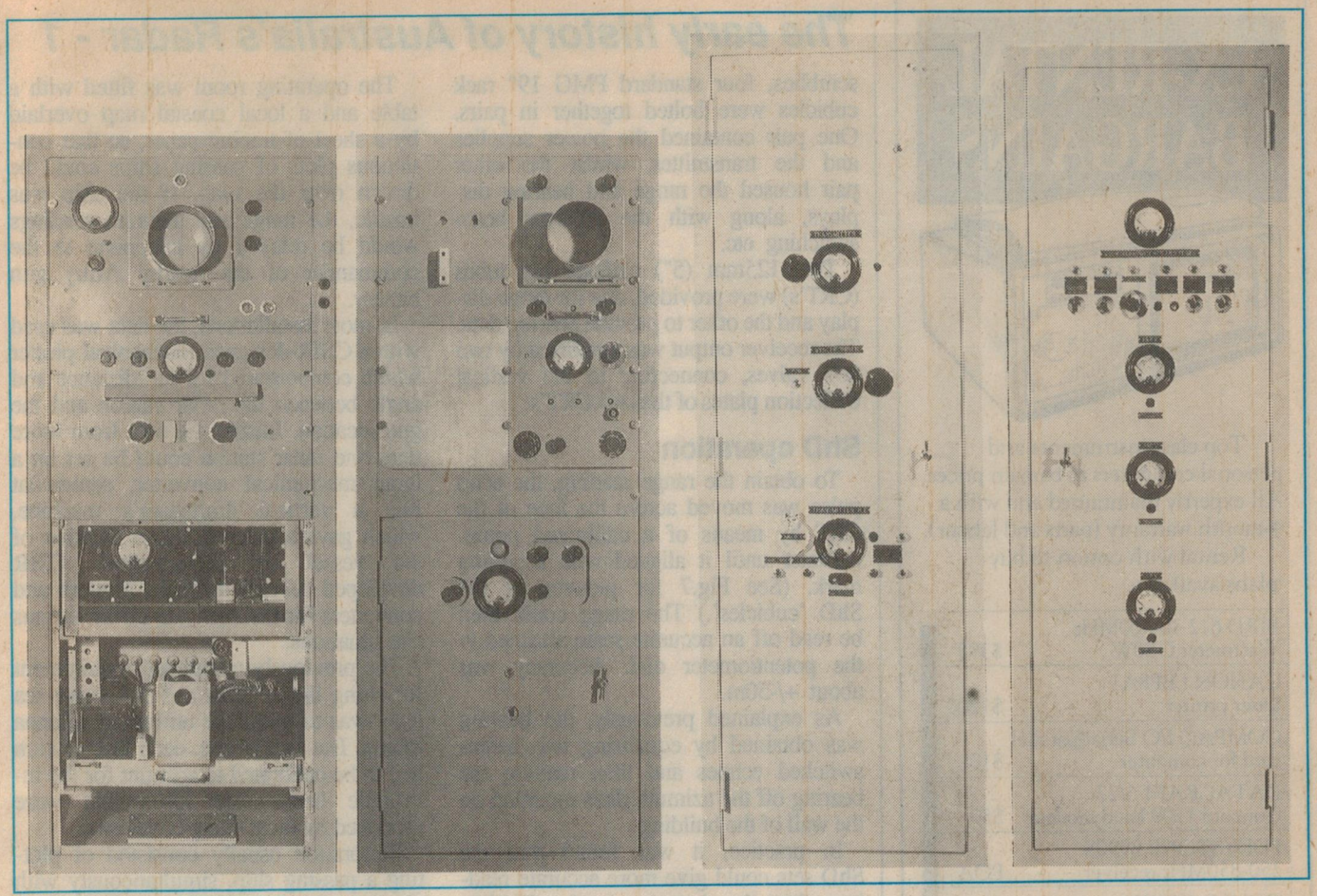


Fig.7:Photos of the original prototype for the ShD radar. From left to right are the range cubicle, with display at the top and time base unit below; next is the bearing cubicle with the bearing display and receiver below it; and finally, the transmitter and power supply cubicles.

about 20 cycles per second. This changed the phasing and caused the polar diagram of the beam to switch back and forth by about 8°.

The display on the oscilloscope was also switched so that two echo pulses appeared, one from each beam. In action the aerial was turned until both pulses appeared of equal height, and this gave a pointing accuracy of around 5' of arc compared to about 2° without beam swinging. See Fig.5 for the concept of beam swinging.

The array could be rotated back and forth through about 270°, driven by a hydraulic motor that was controlled either automatically or manually via servo valves. The bearing, or azimuth, of the array could be read from two dials mounted on the wall of the operating room. These were driven by selsyn servos, one dial showing 5° steps and the other reading to 5' of arc.

The VT90 valve used in the ShD and many other radars had been developed in the UK specially for radar pulse service, and featured an external cylindrical copper finned anode to allow effective cooling. The two VT90's were clamped directly into a circuit comprising two copper tubes as Lecher lines, with a disk type tuning capacitor between the lines as the grid tuned circuit. Output was taken via another close-coupled Lecher line.

The VT90's were held off by a 3000V negative grid bias until the synchroniser, which used an 807 valve, supplied a large positive pulse to the grids at a PRF of 1000 per second. The VT90's broke into strong oscillation with each pulse, for a period of about 1.5us. The operating frequency was around 200MHz. See Fig.6 for a circuit diagram of the ShD transmitter.

Whereas contemporary UK radars produced around 100-150kW, the ShD radar was restricted to only 10kW by the shortage of suitable valves. This was a problem that persisted through the first two or three years of the war, and determined the design of other Australian radar sets.

Although the RPL built and tested a number of different receivers for the ShD, and commissioned others from AWA, the one that was finally used in the ShD and subsequent radars was based on the British ASV MkII receiver and was very similar to that in the J3. It incorporated two RF amplifier stages using the 954 acorn valve, two 955 acorns as mixer and local oscillator, five IF stages at 30MHz with 6AC7 valves and a 6H6 second detector. A 6AC7 was again used as a cathode follower to feed signal to the display units. The bandwidth of the receiver was +/-1MHz. The first RF valve had to withstand a 20V pulse from the ground return echo of the transmitter, and then recover within 2us.

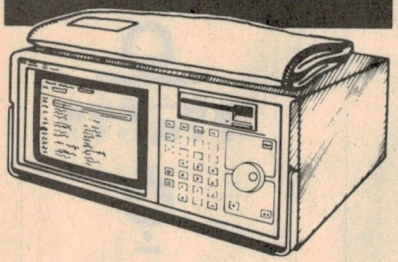
Those who have read of the development of British radar receivers will know that their IF assembly used a 45MHz TRF receiver, made by Pye for the UK television system.

Here in Australia a 30MHz IF was used because the same receiver was to be used with a 76MHz GL radar and it was felt to be a more stable amplifier when tuned to 30MHz.

Later on the receivers for ShD stations were standard ASV MkII sets, also with 30MHz IF, taken from production at the Gramophone Company on Parramatta Road, Sydney, and retuned to 200MHz input.

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READER INFO NO. 7

The early history of Australia's Radar - 1

semblies, four standard PMG 19" rack cubicles were bolted together in pairs. One pair contained the power supplies and the transmitter, whilst the other pair housed the range and bearing displays, along with the receiver beam switching etc.

Two 125mm (5") cathode ray tubes (CRT's) were provided, one for range display and the other to provide bearing data. The receiver output was amplified by two 807 valves, connecting to the vertical deflection plates of the two CRT's.

ShD operation

To obtain the range reading, the echo pulse was moved across the face of the CRT by means of a calibrated potentiometer until it aligned with a setting mark. (See Fig.7 for pictures of the ShD 'cubicles'.) The range could then be read off an accurate scale attached to the potentiometer dial. Accuracy was about +/-50m.

As explained previously, the bearing was obtained by equalising two beam-switched echoes and then reading the bearing off the azimuth dials mounted on the wall of the building.

In practice, it was found that the ShD sets could give more accurate readings than the Army's visual split-view range finders, and of course the ShD functioned in poor light and bad weather conditions.

During operation, the antenna array would be rotated automatically via the hydraulic motor through its arc of coverage, whilst an operator watched the range scope. Beam switching would initially be off, as it reduced the maximum range of the set.

When an echo became visible above the background returns and internal circuit noise (called 'grass' because of its appearance along the bottom of the display trace), the array would be switched to manual control and rotated to give the highest echo on the range scope. It would then be switched to beam swinging. Manual control was exercised via a large handwheel which operated hydraulic servo valves so that the array turned to match the rotation of the hand wheel.

After peaking the echo, the operator would turn the range potentiometer knob until the echo was aligned with a calibration mark on the tube. He would then read off the range in yards, from the potentiometer dial. A second operator watching the bearing scope would call out when he had two equal height return pulses, and a third operator would then read the large azimuth servo dials.

The operating room was fitted with a table and a local coastal map overlaid by a sheet of tracing paper, so that continuous plots of passing ships could be drawn over the map. If the ship was hostile, the range and azimuth readings would be relayed by telephone to the commander of the nearby Army gun battery.

In most installations, the data was used with a CSIR-designed mechanical plotter which compensated for the distance and angle between the radar station and the gun location. Ideally the data from more than one radar station could be set on a large mechanical converter, somewhat like a vertical draftsman's machine, which gave a more accurate location of the vessel by triangulation. CSIR developed several different plotters and converters for the Army, to cover various site situations.

The previously mentioned requirement for siting the antenna at 90m above sea level was to minimise unwanted antenna lobing. But before use, each ShD station had to be calibrated to account for the inevitable beam side lobes that were produced by local siting conditions.

Calibration usually consisted of plotting a passing ship, simultaneously with visual sightings to compare the range. Fixed echoes from nearby islands, etc., were also useful for setting compass bearings and for rechecking the performance of the set over a period of time.

Even so, side lobes were a significant problem, and the recent book *Radar Yarns* relates how the crew of the radar station at Port Kembla plotted some suspicious echoes which grew in number and caused considerable consternation within the Navy and RAAF. Eventually the 'invading ships' sailed 30km inland to somewhere round Liverpool, and it was realised that a combination of propagation effects and antenna side lobes had given false readings — much to the embarrassment of all concerned.

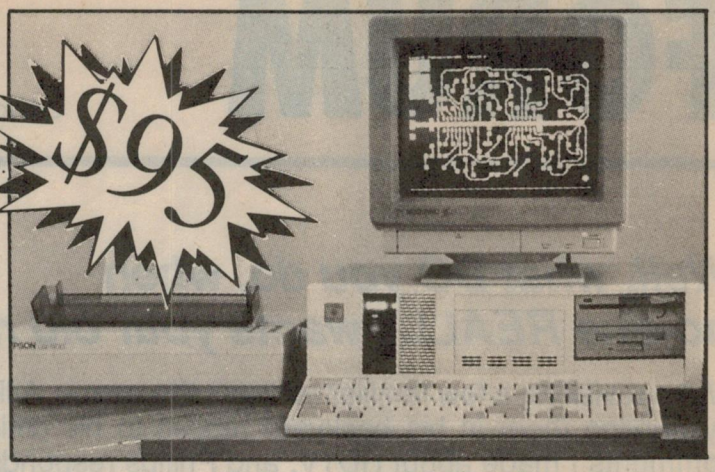
Whilst its design role was to track ships, the ShD could also detect aircraft, but was limited in its range and ability to detect high flying aircraft. Nevertheless some ShD stations did plot enemy aircraft successfully during the war. As it happened the threat to Australia's vital ports had passed by the time the ShD sets were installed, and they fulfilled only a watching brief for the duration of hostilities.

In the second of these articles, we will cover the development of the 'AW' or Air Warning radar.

(To be continued) ❖

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Herman Nacinovich, ETI review "It's a Breeze" Jan. 1990.



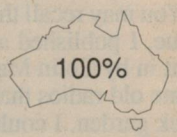
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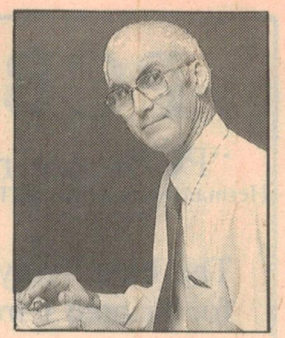
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READER INFO NO. 8

FORUM

Conducted by Jim Rowe



Well, what DO you do, when no-one REALLY wants your old radios?

We're revisiting a few familiar subjects this month, folks. The reader who disposed of his old radios by burying them in his backyard replies to his critics, another reader takes me to task about comments I made about HDTV, and Philips responds to the suggestion that compact fluorescent lamps might emit dangerous levels of ultra-violet radiation.

You may recall that in the August 1992 issue, I published a photo that had been sent in by Colin MacKinnon — showing some old radios that he had buried in his back garden. I couldn't resist doing this, partly because I sensed it would 'stir up' a response from incensed vintage radio enthusiasts, and partly also because I knew Colin himself was actually one of those enthusiasts, and had probably sent the pic to me out of devilment.

Not unexpectedly, there *was* quite a reaction from vintage radio enthusiasts, some of whose letters and faxes I presented in the November issue. Many of those who responded were pretty upset, and made a few rather unflattering comments about Colin MacKinnon himself as well as their disapproval of his action in burying the radios.

Well, I guess some of this criticism must have hurt Colin a bit, because he's sent in a reply to them. And I'm publishing it as the first item this month — not only to give him the opportunity to reply to his critics, but because I believe he makes some very interesting and thought-provoking points, about the attitudes of some of the people involved in vintage radio collecting. See for yourself:

At last I have found fame, but not fortune! Let me respond by giving some background to that infamous photo of my priceless radio dump.

Firstly, I have the utmost respect for history and preservation, as readers of my historical and preservation articles will know. I have a collection of over 400 military radios and perhaps 60 vintage domestic radios, so I did not dump that stuff lightly. I had to clear my garage in a hurry and so I rang four prominent collectors who I considered would be delighted to take the stuff. Do you know what the response was?

(a) "Can you post me a list so I can see what I might want."

(b) "It's not convenient now. Just hang on to it, and when I'm ready I'll come and look."

(c) "It's a long way to your place (25km from the centre of Sydney) — couldn't you drop it into my place one day?"; and

(d) "Yes, I'll come over but I only want a few knobs. I don't want to take the complete chassis." (He didn't turn up anyway.)

I had little option. I looked at those radio parts long and hard, trying to see what could be salvaged, and knew I couldn't keep them. The collectors' response was all one way, so they ended up dumped. I certainly did not get some perverse pleasure from doing it.

I've since heard from others who have a different attitude, and am pleased to help them. As Jim Rowe would know, having seen a small part of it, I recently advised on the disposal of a deceased estate of literally tonnes and tonnes of electronic equipment, components and books. Several collectors who showed genuine interest were able to buy at reasonable prices, things like 1930's era Beales, STC's, AWA consoles and others. Many items were donated to collectors and museums. Unfortunately the sheer volume of stuff in this house and the logistics nightmare meant that tonnes of equipment was still dumped.

I personally took at least a tonne of the best items to the WIA Trash & Treasure Sale — and couldn't GIVE it away! It is all very well to say keep things and eventually someone will want it. That deceased estate was a prime example of the ultimate fate of most such collections.

My photo is really a poignant comment on the attitude of a few radio collectors, as expressed by the lack of interest I found. I have been told that I should have taken the stuff to a club meet or collectors' auction as, for instance, speakers that I had dumped could be reconed for $100 and then sold for $200. So I asked, "Would you pay me $5.00 to cover my petrol costs?" You would have thought I'd asked for their right arm! "But you were going to dump it, so why should I pay anything?" Incidentally I have had several phone calls expressing concern about this same attitude. I have seen collectors bring beautifully restored equipment to sales and couldn't even get scrap metal prices for it. Peter Lankshear's valuation of thousands of dollars does not apply round here.

Coming back to that deceased estate, I asked one collector if he was interested in a rare gramophone console that had turned up. He said he might go as high as $200 if it was in pristine condition. I knew, as did he, of an identical unit in an antique shop for over $1000. Consequently I arranged for that item to go to someone else for around $500 — still a bargain.

So what is wrong? On the one hand I have people complaining that I should keep everything, no matter how much space it takes up and the domestic problems it causes, in the hope that somehow, somewhere, sometime, someone will want it. On the other hand there are those who are not even willing to re-imburse a postage stamp for a list, or make any effort to take stuff away.

I think NSW radio collectors are a bit spoiled and the market has yet to mature. I look at prices paid at collectors' auctions in Victoria, where the clubs and historical groups have been going much longer and I see reasonable values paid, say $30 - $50 compared to silly bids of $1 or $2 for the same items in Sydney. Yet the same bidder feels his own items are



worth hundreds of dollars. In a few years it should level out, and it will be worthwhile keeping parts, knowing that those who want them will make the effort to collect them and will appreciate those who have saved them.

I must point out that it is only a small number of self-interested collectors who influence my cynical thinking. The vast majority of fellow collectors, those I help and those who help me, can rest easy knowing that I don't include them and if I dumped stuff, it was unusable!

(PS: I hear someone is selling maps of my back yard.)

Well, there you are. I think Colin has explained why he did that 'dreaded deed' rather well, and with good humour — don't you?

It certainly seems as if some of our collectors in NSW are not as committed to vintage radio as they might have us believe, too, judging from the kind of responses Colin received when he was still trying to give the old sets a good home as opposed to the burial...

I can also vouch for what Colin says about the deceased estate. It was he who very kindly let me know about it, and as a result I was able to buy not only a car-load of lovely old reference books for the magazine (to replace some of those we lost in our fire), but also a few old but 'classic' Australian-made test instruments for myself. All at a very reasonable price, too.

The chap who was faced with disposing of the estate was in no doubt about the help that Colin had given him in finding 'good homes' for much of the old equipment, too — despite the fact that it was all located a *lot* further away from Sydney than Colin's own modest 25km. So there really isn't any doubt in my mind about Colin's dedication to vintage radio; but by the same token his dedication is tempered with realism, as shown by that photo!

HDTV and MAC

Moving right along, my second letter for you this month comes from Mr Ron Demkiw, of Cabramatta in NSW. And Mr Demkiw wants to take yours truly to task, for my comments about HDTV in the November issue's Editorial Viewpoint. He's also making a belated response to some of the critical comments about MAC systems, made earlier last year by reader Keith Walters. Here's what Mr Demkiw has to say:

I have read with interest your editorial on HDTV, and wish to make a few observations. For a long time I have sought an opportunity to administer a rebuttal to your correspondent Mr Walters, in an earlier issue. But due to the apparent exhaustion of interest in the topic among readers and editor alike, I have refrained from doing so. However some of your comments deserve so much attention that I can no longer restrain myself.

Let me say outright that I think we should still use MAC for satellite TV, even though the future is obviously all-digital. When we are talking about MAC signals, many of the arguments about analogue versus digital become redundant. A MAC signal, in principle, can be any desirable mixture of analogue and digital signals. One line of the MAC signal is devoted entirely to control information which indicates to the decoder the type of signal that is being sent.

A typical D-MAC signal, with a 9us data burst on each line, can handle a data rate of 3Mbps, which is rendered largely superfluous by modern digital audio bit-rate-reduction techniques. This is more than ample to convey a channel of digitally-compressed VHS-quality video, which could be a possible auxillary video service in addition to the normal time-compressed analogue video components. Engineers are confident that they will be able to achieve PAL-

quality video at a rate of 4Mbps. This magnitude of data rate could be attained if the data burst is sufficiently lengthened and the time-compression increased on the analogue video components. In the extreme case, the entire line could be filled with digital data sent at a rate of about 20Mbps.

So it can be seen that, provided we use a MAC signal to start with, a satellite TV service could commence with an analogue signal format to allow early entry, low-cost decoders, and progress in an evolutionary manner to an all-digital system. At this stage, the final choice of a digital video system can be delayed until supplies of consumer chip-sets for digital video decoders are available in sufficient quantities.

Later starters would be able to obtain single-unit decoders for both analogue and digital services. The early starters will only be able to obtain the analogue signals unless they acquire an accessory to enable them to decode the digital channels as well. It is not expected that there will be any special difficulty in persuading subscribers to buy the extra hardware. More services and channels ought to be a powerful inducement to obtain a digital decoder.

It is not a new situation. After all, TV viewers in Sydney do not seem to have any difficulty accepting that they will need extra aerials and a mast-head amplifier to receive Newcastle and Wollongong, but the offerings on the new digital channels should be much more attractive than on the analogue ones.

Late starters will only be able to obtain digital channels, and at this point no analogue decoders remain in service. Prior to the final discontinuation of the analogue service, the data burst may have grown in length by so much that the analogue video components have to be time-compressed to the degree where they cannot deliver more than VHS quality. By this stage the analogue service is only a courtesy service, for a rapidly dwindling audience of subscribers. The picture quality could be the 'stick and carrot' to move all subscribers to digital.

Bear in mind that subscribers may have the option of renting hardware. In that event, the rental company should perform all the necessary equipment updates automatically, so from the subscriber's point of view the transition from analogue to digital will be virtually imperceptible — except that he will gain a greater number of channels.

The Government has decided in favour of all-digital Pay TV, apparently on the advice of Optus Communications. Now Optus may know a lot about mobile phones, but it does not seem to me that they have had a lot of experience in consumer electronics. It is disturbing that they are seemingly basing their plans on verbal promises from American chip makers, that the chip sets for consumer decoders will be ready when Pay TV may begin. It sounds to me like a case of 'vapourware'.

I have a suspicion that Optus and whatever Government is in power are being set up for a huge enbarrassment in 1994 or 1995, when Pay TV may start and no decoders are ready. This happened in Europe in 1989, with D2-MAC. The Pay-TV operators may find that they will be forced to use PAL, and once they do so it will be hard to get them to go digital unless the Government provides subsidies so they can simulcast both PAL and digital.

Therefore, the Government may find that it is in both its own and the public's better interest to begin with MAC. For reasons of financial viability, it will make no difference whether it begins with analogue or digital signals, because there will only be a handful of channels.

The Government needs every justification it can find for using satellite delivery. All-digital Pay TV can just as easily be transmitted via UHF TV 'taboo' channels; the satellite becomes superfluous. MAC is unsuitable for terrestrial transmission, but is ideal for satellite delivery. So if the Government can argue that we have to go via MAC to achieve all-digital TV, it will have a good excuse for using the satellite.

The above constitutes, I believe, the final and definitive vindication of the MAC approach — that is, that it provides a low-risk path to digital TV. Opponents of MAC conveniently forget or ignore the data-carrying capabilities built into the MAC/packet concept.

Thanks for that explanation, Mr Demkiw. I must confess that I for one hadn't realised that the D-MAC system had this built-in ability to provide an evolutionary path from analog video to digital, and I agree that this does make D-MAC much more attractive in a technical sense as a choice for the early phase of Pay TV.

Actually your argument received support from Mr Alan Williams, the Special Projects Manager for Philips, who rang me the day before your letter arrived — again with the idea of gently chiding me for my comments about HDTV. And this is strong support indeed, because Mr Williams is one of, if not possibly *the* most knowledgeable person in Australia when it comes to HDTV and Pay TV. He is well aware of the development and status of the various competing systems, has met and conferred with many overseas experts in this area, and frequently contacts quite a few of them.

I was very interested to hear Alan confirm your explanation of the way D-MAC has this ability to accept a combination of digitised and MAC time-compressed analog video, and therefore as a result can provide a low-risk transition path from MAC analog video to full digital video. In fact Alan explained that this feature was built into the D/D2-MAC system right from the start, because the system's designers had originally intended it to use digital video transmission. Although they were forced by the technical and cost constraints of the day to use time-compressed analog video, they still ensured that the system was 'open ended' to allow for a path to full digital video transmission when this became feasible.

Not widely known...

It's a feature of the D-MAC system that doesn't seem to have been made widely known, until now, so I don't feel too guilty for not having been aware of it. I suspect I haven't been alone, either. All the same, I'm very grateful to both Ron Demkiw and Alan Williams for setting me straight, and hopefully quite a few readers as well.

Mind you, in the leader column concerned I was in fact talking about HDTV, rather than Pay TV. It's easy to confuse the two, because they obviously overlap quite a bit.

Alan Williams confirmed that although HD-MAC has the same inbuilt analog-to-digital video potential as D/D2-MAC, it does require a wider bandwidth transmission channel. So there isn't necessarily a completely smooth and straightforward transition path from D2-MAC to full digital HDTV via HD-MAC, even though there is a fair bit of compatibility between D2-MAC and its wider-bandwidth brother. (For example a D2-MAC receiver can decode and display HD-MAC signals, at its lower resolution.)

Alan also pointed out that the techniques for providing compressed digital video broadcasting in both 'studio quality' and even HDTV have already been developed, so that in theory either could be done almost immediately. But there are still two major practical problems: the lack of agreed technical standards, to ensure that everyone produces compatible equipment and signals, and

UV and Fluorescent Lamps, Compact Fluorescent Lamps

The World Health Organisation adopted the recommendations of the American Industrial Hygenists (ACGIH). Also the National Institute of Occupational Safety and Health (NIOSH) in the USA adopted these recommendations, which have slowly spread to other countries.

Philips Lighting BV also recommends the Permissible Exposure Times (PET) recommended by NIOSH. PET values are intended to insure a safe working environment, and the value represents the maximum permissible exposure time to radiation sources in the work place. By definition, therefore, they have to be greater than eight hours. PET takes into account UV-B and UV-C. Exposure to UV-A is limited by NIOSH to 10W/m^2.

PET values have been calculated for fluorescent lamps, e.g. the PET for the most common tubular fluorescent lamp in Australian commercial premises is more than eight times the limit. The UV-A power is 0.1W/m^2 at 1000lux, which is 100 times lower than the limit. Most buildings would not be more than 500lux — thus 200 times lower.

The PLCE type lamp has even lower values — a UV-A value of 0.09W/m^2 at 1000lux. The average home might not have more than 100lux, thus a UV-A value of 0.009W/m^2. The limit being 10W/m^2, this is more than 1000 times under the limit!

(Statement by Philips Lighting)

the inability at present to produce digital video decoders and decompression chips small enough and cheap enough to provide consumers with sets that they could afford (or be willing to buy).

Finally, Alan also commented that another important advantage of following the D2-MAC transition path to digital video, as proposed by Ron Demkiw, is that it would allow TV studios to adjust gradually to what is inevitably and eventually going to be a major change in video technology.

The studios are already in the process of changing from composite analog to component analog video, which in itself involves many adjustments in the way things must be done in order to maintain picture quality. What they will be facing in the future, as a result of the change to component digital video, will require many more adjustments in terms of editing and other signal processing techniques. How does one edit video and audio that have been time-compressed, for example? Or if you decompress and convert the signals back into analog for editing, and then re-convert and compress them again for transmission, what will be the degree of degradation?

In short, the D2-MAC transition path to digital TV may well provide a low-risk one not only for Pay-TV subscribers and programme providers, but also for the studios and carriers.

It's certainly a point worth considering, don't you agree? My thanks again to both Ron Demkiw and Alan Williams, for pointing out that D2-MAC can in fact provide a path leading to a final fully-digital TV system.

Moving on again, you may recall that in the November issue, I published a letter from Mr Frank Rushworth of Allambie Heights in NSW, who raised the subject of UV radiation levels from fluorescent lamps, and the possible health risks as a result. Mr Rushworth mentioned a study by the London School of Hygiene and Tropical Medicine and the University of Sydney Melanoma Clinic, which he said suggested a relationship between the rise in cases of melanoma, and the use of fluorescent lighting around the world. The study had apparently been reported in *The Lancet*, for August 1982.

Relevant topic

After presenting Mr Rushworth's letter I commented that the topic was a very interesting and relevant one for us all, even though it was a bit out of our own areas of expertise. At the very least, though, it made *me* want to find out more about the levels of UV radiation from fluorescent tubes, and perhaps get hold of a copy of that paper from *The Lancet*. Well, so far I can report only limited success. I've certainly been able to get some official material on levels of UV radiation from fluorescent lamps, from the Philips organisation, thanks to the kind assistance of Philips Australia's ever-helpful PR man George Sprague. I'll reproduce this shortly.

I was also able to make contact with Professor William McCarthy, Director of the Sydney Melanoma Foundation, who is very experienced in this area and has volunteered to write us a short summary of what is currently known about the relationship between fluorescent lighting and melanoma. However Professor McCarthy is a very busy man, and it may be a while before he gets the opportunity to do this. Needless to say I'll present it to you as soon as he does.

Finally, Mr Rushworth himself rang up to respond to my comments about his letter, and has kindly offered to loan me a copy of the original paper in *The Lancet*. This hasn't actually arrived as yet, though, so I haven't had the opportunity to study it before this month's deadline drew too close for comfort.

Right at the moment, then, all I can give you is the official statement from Philips, which is reproduced in the box.

As you can see, it's pretty reassuring with regard to the UV emission levels from both long-tube and compact fluoro's when they're new, and in relation to what appear to be accepted world safety standards.

However there's no mention of how this situation might change when tubes get older. As Mr Rushworth pointed out, it's not unusual for the phosphor coating to flake off inside the glass of long-tube fluoro's, and one wonders what happens to the UV emission levels when this occurs. I've asked George Sprague to see if Philips Lighting has any information on this aspect, and he's currently checking with the appropriate experts. Needless to say if any further information arrives, I'll present it in a forthcoming column.

And that's all for the present. I hope you'll join me next month. ❖

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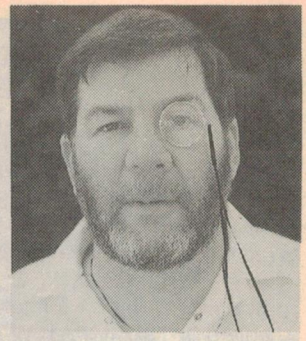
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READER INFO NO. 10

Moffat's Madhouse...

by TOM MOFFAT



Brave New World

There were ten seconds of complete darkness; then suddenly, dazzling and incomparably more solid-looking than they would have seemed in actual flesh and blood, far more than reality, there stood the stereoscopic images, locked in one another's arms, a gigantic negro and a golden-haired young brachycephalic Beta Plus female.

The Savage started. That sensation on his lips! He lifted a hand to his mouth; the titillation ceased; let his hand fall back on the metal knob; it began again. The scent organ, meanwhile, breathed pure musk.

Expiringly, a sound-track super-dove cooed 'Oo-ooh'; and vibrating only thirty-two times a second, a deeper than African bass made answer: 'Aa-aah.' 'Ooh-ah! Ooh-ah!' the stereoscopic lips came together again, and once more the facial erogenous zones of the six thousand spectators in the Alhambra tingled with almost intolerable galvanic pleasure. 'Ooh...'

Those words were written in 1932, by Aldous Huxley in *Brave New World*. And now, 60 years on, they're starting to come true, as 'virtual reality'. Well, not the words exactly, but the technology suggested in that passage is now being developed with a vengeance.

Huxley's setting was a cinema, the Alhambra. But it didn't run 'movies', it ran 'feelies' — the ultimate experience that was bigger than life itself. The viewer wasn't a viewer, but a 'virtual' participant in what was happening, with enhanced senses of vision, sound, smell, and touch.

And it wasn't hard to imagine in that particular 'feelie' what was taking place, or was about to take place. That kind of titillation got *Brave New World* banned in Australia for four years, on the grounds that it was pornographic. After all, Huxley was the first to describe a particularly well-endowed woman as 'pneumatic', and his book was full of them.

I don't think it will be too long before we will have cinemas like Huxley's Alhambra. It wouldn't surprise me in the least to see a pretty good approximation of it by the end of this century. We already have the audio side of the Alhambra in some of our present cinemas, with 'Surround Sound', or 'Sen-Surround'. This is basically multi-channel sound, recorded with the picture so that sounds can be made to appear to be coming from anywhere in the theatre.

The technique uses big, big speakers, so it's a snap to produce sound that is 'vibrating only thirty-two times a second'. And ever since the first days of talking pictures, cinema sound has always been big, loud, almost overpowering.

People sometimes complain about movies being too loud, but they just wouldn't be the same if played softly. I sometimes play rented videos through my home stereo system, quite loudly, but it still can't match a big cinema system in full roar.

Smell — well, that's been experimented with, but not too successfully. I have heard of, but never experienced, movies in which scents are released into the audience at certain times, as when the picture shows newly mown hay. I gather Huxley's 'scent organ' was probably a console with keys which could be pressed to mix and release scents on cue, just like the laugh organs used to 'spice up' inane television sit-coms.

As for the sense of feel, well, that's already been tried too. I remember there was once a film, called *Earthquake* I think, which was designed to be shown in specially adapted cinemas. In these the seats were modified so they could be made to shake and quiver during the earthquake sequences in the film. Again I have never experienced this, but I'm told that just a small suggestion of movement makes the film very realistic indeed.

For vision, the old-time 3D films had to take the cake. I don't know why they went out of fashion, because they produced truly stunning effects.

I remember one 3D film when I was a kid, that featured a landslide at an unexpected moment. The audience of course was right at the bottom, directly in the path of the landslide, and we saw great boulders tumbling down the hill and then bursting right through the screen into the cinema. I was down behind the seats in a flash!

It's got to be one of the most realistic things I've ever seen on film. Now, if they'd arranged the seats to shake while the audience cowered behind them...

Yeah, good stuff, and there's obviously a market for it. Several years ago a Hobart cinema brought back an old 3D movie for a short run, but I never got to see it. For two nights running I left straight from work for the cinema, but it was 'full house' by the time I got there, even an hour before the film's starting time.

If you take a 3D cinema, make it smaller, and plop it on top of your head, you've got VIRTUAL REALITY as it is in today's experimental form. The 'helmet' contains two small picture tubes, one in front of each eye, running stereoscopic images. (For 3D movies we wore special glasses.)

There is also a sensor arrangement so if you swivel your head around, the view presented to your eyes moves to match. You look around to the left and there is a chair, for example.

But where virtually reality really gets interesting, is if you decide to walk over to the chair. Your eyes see it getting closer and bigger, and its apparent angle changes as you move around to the front of it. But if you then sit down, you're in big trouble — because the chair ain't there!

In today's experiments the images you see are usually computer generated, and they're very simple — mostly stick figures — because the computer has to continuously calculate a new perspective for every movement you make, and re-display it to you in real time.

But this will improve, and before long you will be able to take the hand of a

beautiful girl and walk through a field of yellow wildflowers.

You will have to dodge the bees that are sharing the field with you. If you look around to the left you can see a mountain peak, with patches of snow, just slightly higher than the meadow you're walking through and very nearby.

Turn your head to the right and there is a crystal-blue lake, reflecting rain clouds which are coming toward you. Ahead is a ramshackle hut, with a tin roof and holes in its rough timber walls. It appears bigger as you run toward it, and you get there just in time to escape a torrential mountain rainstorm. The first drops of rain are freezing cold, but the inside of the hut is still warm from the sun. As the hut cools, you and the girl cuddle up together, and outside, thunder shakes the ground...

That last paragraph was conjured up from a favourite memory — the place, 10,000 feet up in the mountains of New Mexico, not far from where Huxley's 'Savage' came from. The girl's name was Marion.

That stuff did happen, and if it were somehow recorded in 'virtual reality' I could put on the helmet, hit the rewind and play buttons, and make it happen again whenever I wanted. No mental pictures, the 'real thing'; the buzz of the bees, the vibrant yellow of the flowers, the smell of their perfume and the soil and the ozone in the air as the thunderstorm approaches, the soft touch of Marion's hand.

In fact, had a full blown version of 'virtuality' (new word just coined) existed back then, there would probably have been a pre-recorded experience of a walk through a mountain meadow, just like you can get pre-recorded adventures on video now.

I could have saved the trouble of slogging my way up that 10,000 foot mountain; I could have saved the trouble of convincing the fair maid Marion to come with me. The mountain, the meadow, the flowers, the girl, could all have been nothing more than impulses on a magnetic tape. I could simply put on the helmet, lie back on the couch, and have my experience, without ever actually 'having' it.

When I was poking around through *Brave New World*, I was looking for another form of the 'feelies' I'd read about, but I guess I got the wrong book. In this particular story it was possible to take a complete holiday by 'virtual reality'. The participant did just as I suggested above — put on the helmet and rolled the tape.

You could have three weeks in the Whitsundays without leaving your chair, and as I remember this particular virtual reality device even presented you with holiday snaps when you 'got back', for you to show to your friends.

Let us now imagine, a few years in the future, every home video machine is made obsolete and replaced with its virtual reality equivalent. You could go to your corner 'experience library' and hire a two-week holiday in London for six dollars.

You would return the tape the next morning. Your mind had been gone for two weeks, but your body had been perched in the chair for a couple of hours. Imagine — a two-week holiday every weekend if you wanted, and no need to take time off work!

Wouldn't that be great? No need to go on a journey any more, no more use of fossil fuels, no pollution; planes, boats, and trains all in museums. Well, not museums, but 'virtual' museums, on magnetic tape. You'd never actually have to 'travel' again...

NO! I say PHOOEY to the whole idea.

Your holiday, your adventure, your experience, would be pre-programmed, with nothing left to chance. Nothing unexpected, and in any case the very act of 'travel' is half the fun. When I went to the Antarctic, the high points of the whole trip took place on the ship, cruising among the icebergs and the Antarctic coastal scenery.

(An aside: I have travelled on two ships in my lifetime, the *Empress of Australia* and the *Nella Dan*. Both ships subsequently sank. Perhaps I should strike an arrangement with P&O or someone, NOT to travel on their ships for a small monthly fee...)

In fact with 'virtuality' there may be no need to go to work. You would get the satisfaction of 'work' and being an important person via the helmet on your head. Don't worry, the state would support you, and eventually you would never have to leave your chair. Your whole life through a helmet! The ultimate couch potato...

My trouble is I LIKE to work. I enjoy sitting here writing this drivel for you. I would get pretty sick of sitting there day and night with a helmet on my head. Life would be too perfect, and that's too boring.

Some other things in *Brave New World* have already come true, to a degree. In that world, citizens were given never-ending supplies of little pills called 'Soma', to help people relax and to make it unnecessary to ever face tension. In our world these pills are known as 'Valium' or more recently, 'Prozac'. They are not yet on general issue, although doctors sometimes arrange supplies for people who have a need for some chemically-induced comfort.

In *Brave New World*, babies were not born; they were produced in glass vessels filled with a nurturing solution. We can now conceive babies in 'test tubes'; it shouldn't be much harder to bring them up to birth weight in a bottle. Never again would a woman need to feel the pain of birth, and the resulting kiddies could be carefully conditioned to take their pre-destined places in society — never questioning, never rebelling.

Have you visited a friend in hospital lately? In Huxley's 1932 hospital, 'Propped up on pillows, she was watching the Semi-finals of the South American Reimann-Surface Tennis Championship, which were being played in silent and diminished reproduction on the screen of the television box at the end of the bed. Hither and thither across their square of illuminated glass the little figures noiselessly darted, like fish in an aquarium — the silent but agitated inhabitants of another world'.

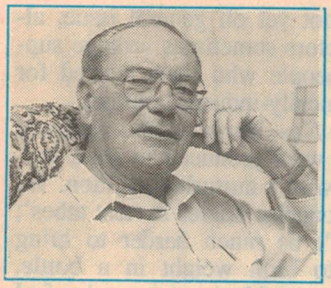
Huxley hit the nail on the head that time. The television is exactly as we know it, it sits in the conventional place on the little trolley at the end of the hospital bed. The pictures are as we know them, never-ending tennis for hour after hour after hour.

Huxley seemed to be warning us of technology run wild, in *Brave New World*. The copy of the book in front of me is from my daughter's school library. Students have been studying the book from a literary point of view: there are notes in the margins, such as 'clear picture of bitterness', 'solitude feeling', and 'Bernard's identity development'.

But I wonder if the students are concentrating so hard on the writing style that they are missing Huxley's warning to them, about what their future could bring.

These students are our future scientists, our future engineers. They will decide if their lives will have diversity and adventure, or whether they will spend their days in a haze of Soma and virtual reality. But does future society have any right to try to rebel against 'progress', as did the fellow known as The Savage in *Brave New World*?

The ultimate student comment comes below the last paragraph of *Brave New World*, where The Savage finds the final solution to his torment. The comment says, 'Neither side is right'. Now let's think about that for a moment. If progress isn't right, and anti-progress isn't right, what *is* right? ❖



When I Think Back...

by Neville Williams

PA systems 1: a belated spin-off from wireless/radio technology

One might be excused for concluding that public address or 'PA' amplifiers have always been with us — or certainly for as long as wireless/radio itself. In fact, public broadcasting had been established for 15-odd years before PA systems became part of the everyday scene. In this article and two that will follow, we trace their evolution from humble beginnings to the acoustic monsters that are used at modern-day functions.

As established in the 1920's, the basic role of 'wireless' broadcasting was to distribute speech and music from centralised transmitting stations to individual receivers, without having to rely on wires (landlines). At the receiving end, the programs were reproduced on headphones or modest loudspeakers, the obvious requirements being that the recovered sound be loud enough for comfortable listening in the home and as free as possible from sonic distortion and spurious noise.

Beyond these basic objectives, designers tended to concentrate on developing receivers which were reliable and simpler to control, which offered access to an adequate number of broadcasting stations and which were economical in terms of price and battery drain.

Science writers certainly speculated about future developments — even to distributing electric power by wireless — but manufacturers, engineers and technicians in the 1920's had their work cut out in coping with the technicalities of ordinary broadcasting.

For the sound to be heard comfortably on headphones in an average home, the audio drive power required from the receiver did not need to be more than a few milliwatts (thousandths of a watt), or 150-odd milliwatts for a loudspeaker.

Most valves, loudspeakers and other receiver components of the day were designed to satisfy these basic requirements, and it was left to the visionaries to dream about 'wireless' equipment that might, one day, be powerful enough to provide speech and music for public gatherings, as distinct from a home.

An orchestra could indeed flood an auditorium with generous sound, as also could a band or a pipe organ. But the most effective vocalists, actors, elecutionists, preachers and politicians were those with powerful voices — who, unaided, could make themselves heard in such an environment! Indeed, many such regarded the ability to do so as one of their innate skills and did not take kindly to the idea of electrical sound amplification.

'Once upon a time'

In a recent documentary about vaudeville on ABC TV, veteran entertainers Ron Shand and Ernie Bourke recalled the introduction of an amplifier system to Sydney's once popular Tivoli theatre — presumably in the late 1920's, when vaudeville was fighting a losing battle with the then-new sound films. As amplifiers go, that first Tivoli installation would appear to have been quite basic — well before the days of multiple microphones and audio mixing panels.

Dating in Australia from about 1902, vaudeville had developed a tradition of spontaneity in the presentation of 10 or so variety acts, with participants timing their entrances to musical interludes from the band, appearing on stage from wherever and addressing the audience as they did so.

With the Tivoli's first PA system, a lone microphone would be pushed up by a stagehand through a mini-trapdoor at front centre stage, and performers were expected to make their entrance and position themselves in front of it before

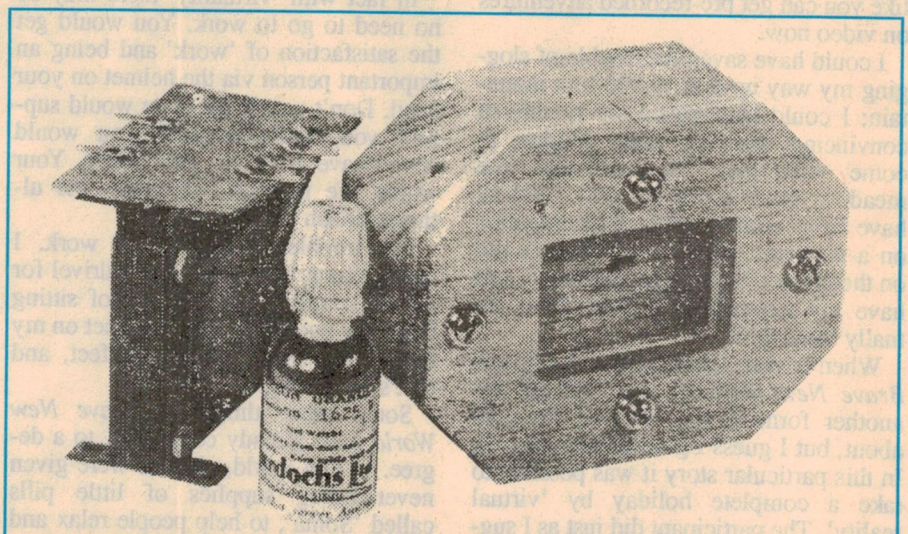


Fig.1: Advertised in the October 1939 issue of 'Radio & Hobbies', a kit which once enabled hobbyists to assemble their own transverse current (Reiss) carbon microphone.



Fig.2: An Australian-made D104 crystal microphone, distributed by ETC Industries and featured in the August 1941 issue of 'Radio & Hobbies'. It was said to have been specially designed to resist the effects of humidity.

saying a word. Failure to do so was to invite a curt memo from management.

The performers hated it, they said, because it cramped their style. Sprouting from the stage floor like some mechanical weed, the microphone created its own diversion, particularly when the actor overshot the mark in the glare of the stage lights and the microphone collided with their posterior!

Everyone concerned clearly had a lot to learn about sound amplification. Designers had yet to come up with equipment that met the requirements for stage production. Performers, in turn, had to work out how best to use a microphone to enhance their presentation.

Watts, not milliwatts

As already indicated, receiver technology in the early 1920's was inadequate for sound reinforcement because the sound level it could deliver was less than that of a performer's own voice and way below the level from an orchestra, band or pipe organ.

In addition, available loudspeakers produced a 'tinny' sound, tolerated for wireless reception by reason of its novelty but unacceptable at a live performance.

Sound reinforcement became a viable proposition only when mains type power supplies justified the development of high-voltage, high-current valves and techniques offering power output levels of five watts or more. About the same time, horn-type and moving-armature cone loudspeakers gave place to moving-coil ('dynamic') types, capable of greater sound level and with a more natural tonal balance.

Indeed, by the early 1930's, receiver technology had reached a point where it was possible to assemble a practical amplifier from catalog components — sufficient to be heard throughout a modest auditorium.

Oh for a mic!

In terms of sound reinforcement, however, one major impediment remained: the provision of an acceptable microphone — one that offered reasonable tonal balance with speech and music, free from obvious distortion and background noise.

High quality microphones were available to professional users such as broadcast stations and recording studios, but at a price that largely precluded their use in physically exposed, low-budget applications. (High quality professional 'condenser' mics will be discussed in parts 2 and 3.)

In practice, the lack of suitable microphones proved a hindrance to the widespread use of public address amplifiers until at least the mid 1930's. Indicative of the fact is that, in the February 1940 issue of *R&H* (p.43), Editor John Moyle heralded the appearance of public address equipment at indoor and outdoor gatherings as 'one of the most important phases of radio... over the last year or two'!

Of necessity, in the early 1930's, most experimenters and amateur radio operators had to settle for 'single-button' telephone type carbon inserts, which were suitable only for basic speech communication.

So-called 'transverse current' or 'Reiss' carbon microphones were much better and were even used by some broadcast stations, for non-critical applications, into the early 1930's. In 1939, Murdoch's of Sydney were still offering a complete kit for a home-built version for 29/6d ($3.00), as shown in Fig.1.

It comprised a machined block of solid teak, with a rectangle about 5mm deep routed into one face. Metal strips (ideally gold plated) had to be secured at each end to the internal face of the recess, with contact studs passing through the wooden block to two terminals at the rear of the assembly.

With the microphone on its back, the rectangular recess had to be partially filled with fine carbon granules (supplied), after which it was overlaid with a thin mica diaphragm, secured by a faceplate and protected by a spacer and grille. When the fully assembled microphone was turned right way up, the granules would typically occupy the lower three-quarters of the recess.

In use, the microphone would be connected by means of a two-wire cable into a series circuit involving one or more dry cells and the primary of a step-up transformer. Current would flow through the circuit, depending on the applied voltage and the resistance of the carbon path bridging the two metal strips.

Sound-pressure waves impinging on the mica diaphragm would alternatively increase and diminish the pressure on the entrapped carbon granules, varying their instantaneous resistance. The changing current would induce a corresponding audio voltage across the transformer windings, thereby providing an audio signal for the associated amplifier.

Shortcomings...

I was one of the many enthusiasts, in those days, who built up a transverse current microphone. It worked — but it also shared the practical problems which limited the utility of the species:

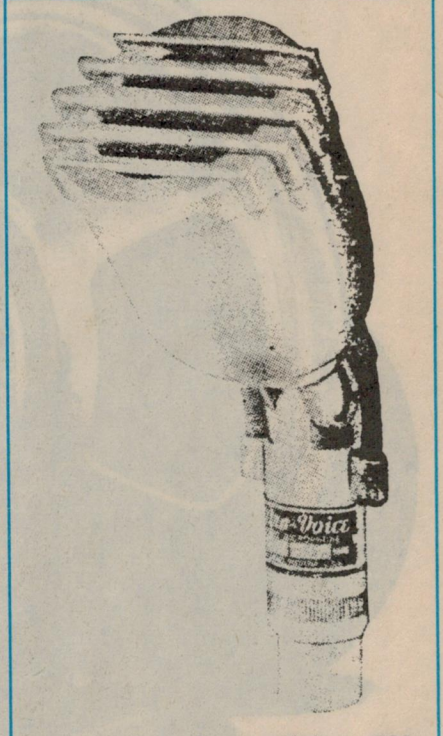


Fig.3: An Electro-Voice 620 dynamic microphone distributed in Australia in 1939. Numerous modern dynamics are currently available from electronic component suppliers in the range $10 - 100, depending on specifications.

WHEN I THINK BACK

1. The standing current through the granules generated a background hiss ('frying'), which required that the mic be used close-up to ensure an acceptable signal/noise ratio;
2. The variation in the resistance of the granules as the diaphragm moved in and out was not linear, resulting in harmonic distortion;
3. Physical movement of the microphone as a whole could generate a noise signal, such that it was normally spring mounted inside a support ring atop a firm stand. Reiss mics could not readily be hand-held;
4. While of little consequence in a radio studio, the bulk of such a microphone in front of a performer's face posed a problem in live audience situations.

Not surprisingly, considering the limitations of carbon types, the emergence of 'crystal' microphones in the late 1930's sparked a great deal of interest, especially when they were developed and marketed as inexpensive capsules or 'inserts'.

Crystal mics

Using much the same basic principle as a crystal pickup, incoming sound waves would cause slight movement of a diaphragm, which would be transferred to a thin wafer of crystalline Rochelle salt (sodium potassion tartrate). Due to the so-called 'piezoelectric' effect, sonic vibration of the wafer would cause a corresponding small audio voltage to appear between its opposite faces, thereby providing the requisite output signal. (In so-called 'sound cell' crystal mics, the sound waves impinged directly on one or more wafers. They offered a smoother frequency response and lower distortion, but at the expense of output signal level).

Crystal microphones could be made relatively small and light, required no energising battery, generated no background hiss and were largely free from handling noise.

They exhibited a high capacitive impedance, however, and normally had to be used with a shielded cable no longer than about three to four metres. For longer cable runs, a 'buffer' preamplifier was normally required. The Rochelle salt crystal wafer also proved vulnerable to high levels of ambient temperature and humidity.

For these and other reasons, crystal microphones gravitated mainly to a speech/utility role, being widely used with amateur and other communication transmitters, paging systems, streetside 'spruiking' amplifiers and PA systems at sporting events — applications where they could normally be connected to the companion amplifier via a suitably short cable.

(Modern 'ceramic' mics are similar in principle to crystal types, but use a wafer of barium titanate ceramic and are unaffected by heat and humidity. They can also be fitted with a transistor buffer stage, to allow use of longer cables.)

Possibly the best known of the original crystal types was the American designed Astatic type D104, illustrated in Fig.2.

Like other Rochelle salt crystal devices, it didn't take too kindly to extremes of heat and humidity but it was otherwise robust and reliable. Tending to favour voice frequencies (500 - 4000Hz), it ensured crisp if somewhat 'metallic' speech but was unflattering to music.

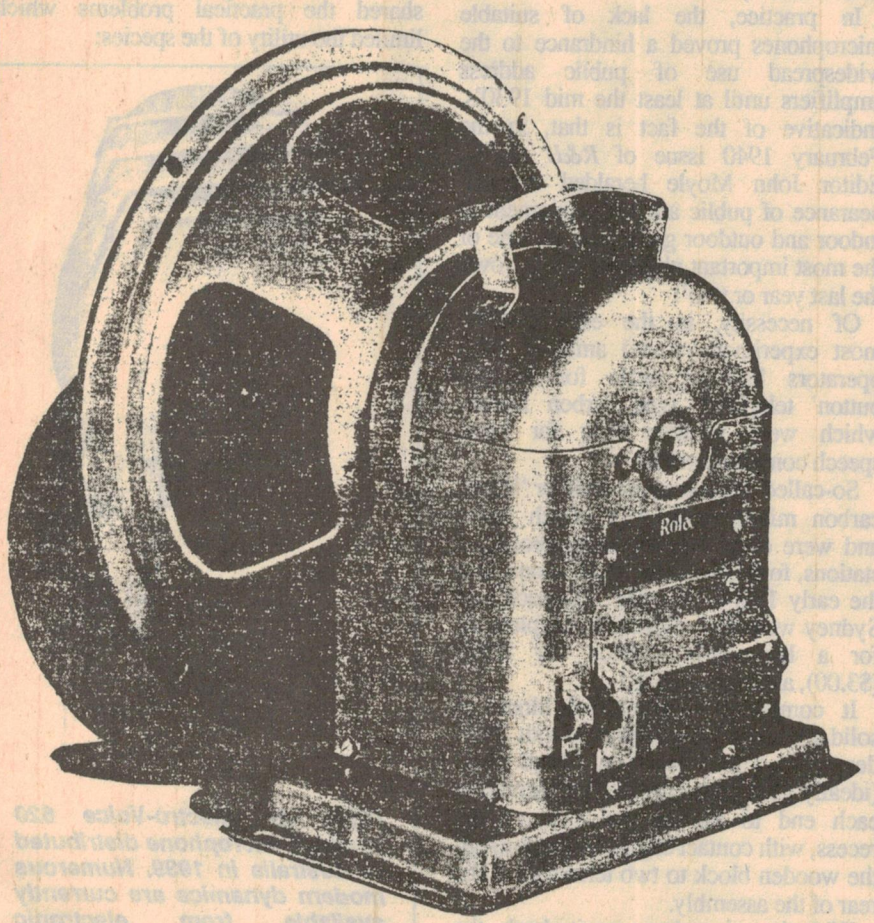


Fig.4: The Rola G-12 electrodynamic loudspeaker, as advertised in R&H for March, 1942 'For Public Address'. The retail price was quoted as £9 ($18) — which represented a much larger outlay than it sounds today!

Mic for all uses

As it happened, 'dynamic' microphones emerged about the same time, as a further option. As implied by the name, they used the same basic principle as a (permanent magnet) dynamic or moving coil loudspeaker, but in reverse: incoming sound waves impinging on the cone caused equivalent movement of the voice coil in the magnetic gap, generating a corresponding audio voltage across the coil.

From such a low impedance source, the signal could readily be fed through a long, shielded cable to the input circuit of a distant amplifier, directly or through a voltage step-up transformer.

Actually in the early 1930s, it was not unusual for enthusiasts to use small loudspeakers as makeshift microphones, even to the extent of mounting them between conical perforated metal shells to help them look the part. Unfortunately, at a time when even a 'small' loudspeaker could be four or more inches (10mm) in diameter, a dynamic microphone contrived in this way could be just as cumbersome as a transverse current carbon type. True, it would be free of background hiss but, due to the mass and stiffness of the motional system, its overall performance as a microphone was normally mediocre.

In the quest for good all-round performance, purpose-built dynamic microphones used a more compact mag-

net structure, coil and suspension system and a very light cone, protected by a rugged housing. By coincidence, the same page in the October 1939 issue of *R&H* which featured the transverse current carbon mic shown in Fig.1 also carried an announcement of the Electro-Voice 620 dynamic mic, as available from Amplion Australia (Fig.3).

It was said to offer a frequency response of 40 - 10,000Hz, with a slightly rising characteristic. It could be used as a directional mic by pointing it at the source, or for non- directional pickup by pointing it vertically upward.

A miniature step-up transformer could be housed in the rear of the case, such that the 620 could be supplied at 50, 200 or 500 ohms for cable working, or with 'high impedance' output for direct connection to an amplifier input.

At the advertised price of £12 ($24) the E-V 260 was almost four times the price of Murdoch's transverse current carbon mic kit. But it signified the future rather than the past and would have been acceptable, in its day, for speech, stage and concert use. It and others like it, such as the Astatic dynamic DN-50, would certainly have been compatible with public address amplifiers, large and small.

('Ribbon' microphones, essentially a variant of the 'dynamic' concept, were also available in the 1930's for professional and advanced hobby use. They offered good quality in a controlled environment, but generated relatively low signal output and were potentially vulnerable to wind outdoors, speech 'puffing', etc.)

Loudspeakers for PA

If microphones had to emerge to meet the basic needs of public address, so also did loudspeaker driver and enclosure configurations. An endless array of new dynamic drivers was being released for 1930's-style mains powered receivers, and PA enthusiasts were quick to recognise models with a reputation for ruggedness and reliability.

High performance models by American firms Jensen and Magnavox were especially favoured, and Rola Australia also made a bid for the prestige market with their very successful G-12 (Fig.4).

In domestic radio receivers, drivers were normally mounted on a flat baffle in furniture style cabinets — the larger the better!

In churches or other venues, where decor was important, drivers for public address systems were commonly housed in suitably finished rectangular enclosures fixed to walls and facing out over the audience.

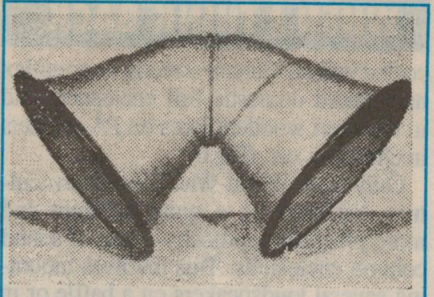


Fig.5: A decidedly 'odd' double-flare loudspeaker illustrated in R&H for October 1939. Announced by University Laboratories, New York, it featured rubber rings around the flare edges, supposedly 'to reduce resonance effects'.

Contrived and installed, in many cases, by a willing handyman, early PA enclosures were frequently too small for the chosen driver — producing a rather 'boxy' sound, with little true bass. They were not very directional and the reproduced sound could be further compromised by building echoes and howling due to acoustic feedback into the microphone(s).

For outdoor or temporary installations, drivers were often fitted with a commercially-made spun aluminium flare 40-50cm long, and directed towards the audience. The rear of the driver would normally be enclosed in a matching metal shell, with or without internal padding (see also Fig.5). Flared drivers certainly looked 'professional' and directional, but how effective they were acoustically and how well they limited feedback by diverting sound from the microphone is open to question. They also limited the deep bass response, much like a too-small enclosure, to the detriment of the overall quality.

Horns and columns

The ultimate horn loudspeaker for public address was/is the so-called 'exponential' type — a description reflecting their mathematical derivation, dating back to the days of Edison and the acoustic phonograph.

Expanding from a diameter of a few centimetres at the throat to over a half-metre at the mouth, over a distance of a metre or more, straight exponential horns were/are notable for high directivity and acoustic efficiency. A cluster of exponential horns in the centre of a sports arena can readily cover grandstands and/or a large audience spread around the perimeter, and with a relatively modest amount of audio drive power.

Because of their unwieldy shape, however, and the restricted bass-end response of designs with practical dimensions, true exponential horns have been limited mainly to speech coverage of outdoor events — principally the domain of companies specialising in large-scale public address.

(In the case of folded or re-entrant horns, the overall bulk is reduced by folding the horn back within itself. They tend to be less awkward, but also less efficient).

After decades of horns atop Edison phonographs, old-time wireless sets and PA vans, it is perhaps not surprising that a degree of horn 'culture' should be evident in the design of loudspeaker enclosures generally. It was/is evident in the huge full-range systems that are often con-

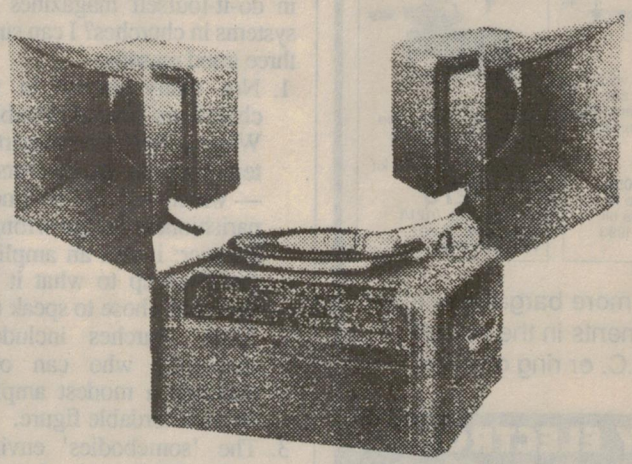


Fig.6: From R&H for September 1939, one of a series of Webster-Chicago PA amplifiers distributed in Australia by International Radio Pty Ltd. Power outputs ranged from 8 - 60W. The loudspeakers used 12-inch (30cm) drivers in small wooden cabinets with frontal flares.

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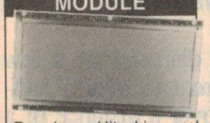
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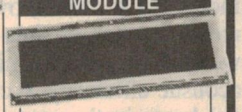
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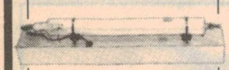


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WHEN I THINK BACK

cealed behind cinema screens, in complex horn-based domestic hifi enclosures and in the short wooden flares on PA cabinets in churches, etc. (Fig.6)

Only after World War II was horn culture displaced by a quite different and more practical approach — that of sound column enclosures. This involves mounting several loudspeakers on a baffle or in an enclosure, one above the other, operating in phase. A popular choice is four drivers, with their voice coils wired in series-parallel to present the same impedance as a single driver.

The radiation pattern of such a group is a flat, horizontal fan shape, which can be directed out over the heads of the audience, but extending across the whole frontal area. Sound from a suitably elevated column passes above the front rows, so that the close-up audience is not subjected to an excessive sound level. Those towards the back, however, benefit from the full sonic beam.

As a further bonus, the fan-shaped pattern reduces sound level below the beam, easing the microphone feedback problem. Again, by also minimising the sound level in the ceiling area, echoes in lofty buildings can be reduced.

A slim enclosure for several small vertically-aligned drivers can also be less intrusive, visually, than a chunky box housing one large driver — so that, in practice, more favourable bass loading can be achieved. These days, sound columns range from slim enclosures in churches to huge vertical 'walls of sound' at outdoor rock concerts.

Why church PA?

Churches? Why the frequent mention in do-it-tourself magazines of early PA systems in churches? I can suggest at least three good reasons:

1. Not many people in the average church are trained in public speaking. When called upon to participate, they tend to speak at a conversational level — which may not be loud enough for parishioners on the wrong side of 60. Answer: install an amplifier to bring the level up to what it would be if everyone chose to speak up!
2. Most churches include or know somebody who can organise and maintain a modest amplifier system for an affordable figure.
3. The 'somebodies' envisaged above are likely to be readers of magazines like *EA*, and it has therefore been logical for *EA* over the years to provide information at their level of involvement.

Similar considerations apply to many other community groups and venues. Perhaps I should add that an amplifier does not always solve their problems. Discomforted by the sound of their own voice, many folk intuitively speak more softly or back away from the mic, despite requests to the contrary. In other cases, the problem turns out to be diction rather than decibels, and the amplifier merely makes louder what is still difficult to follow.

It was against this background and John Moyle's observation quoted earlier, that I decided to feature articles about basic PA systems when I assumed control of *Radio & Hobbies*, back in February 1942.

The information was certainly basic — mention of typical magnetic and crystal (78rpm) pickups and a survey of available hobbyist microphones, ranging from an Amplion transverse current carbon to an Australian-made ribbon type from Vealls of Melbourne. A couple of 5-watt amplifiers were featured, following familiar receiver practice, plus an article on loudspeakers and associated wiring.

In later years, we described rather more ambitious PA equipment — but always aimed at hobbyist readers.

My own pet system in the old days was a compact mono mains-powered amplifier using a couple of 6BW6 power valves in push-pull to deliver a nominal 15W of output. A couple of preliminary stages provided mixing facilities for two mics (typically dynamics), with one channel being switchable to Aux/PU/-Tape input.

The amplifier fed two internally padded, wooden loudspeaker cabinets measuring 460(H) x 260(W) x 220(D)-mm. Each contained two wide-range, low resonance 150mm Magnavox drivers, mounted one above the other, forming a mini-column. They were wired in series, in phase to present an impedance of 15 ohms per enclosure — or a load of 7.5 ohms with both systems plugged in.

In use, they could be positioned one either side of the stage, to cover a square auditorium. Alternatively they could be stood one upon the other to form a single tall sound column, able to serve an audience of 200 or more in a long, narrow building. Either way, the quality was excellent for both speech and music.

Next month

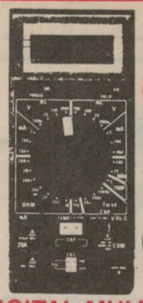
So much for PA at a predominantly amateur/hobby level. It should serve as background for part two in the next issue: the story of Laurie Simon, founder of Nomis Electronics, who can lay fair claim to being the pioneer of professional PA in South Australia.

(To be continued) ❖

ROD IRVING ELECTRONICS

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INTRODUCING OUR NEW RANGE OF MULTIMETERS AND TEST EQUIPMENT!



NEW In 1993

WOW 20 AMP CURRENT RANGE

DIGITAL MULTIMETER HC-3500T

The HC-3500T is completely portable, pocket sized 3 1/2 digit multimeter designed for use by the engineer, technician, and hobbiest who demand an instrument, that is accurate, reliable and always ready for use. Equipped with nine functions and 28 ranges, each test position is quickly and easily selected with a simple turn of the single selector switch. Small enough to fit in attach cases and equipped with a multi-position tilt stand. The instrument is equally suited for design engineering, production testing, field servicing and industrial maintenance applications.

- Display: 3 1/2 digit
- Basic Accuracy 0.5% DC
- DC Voltage: 0-100V
- DC Current: 0-20A
- AC Voltage: 0-20A
- Resistance: 0-20M ohms
- Temperature: -20°C - 1200°C
- Continuity test, Diode test, Temperature, Capacitance, Frequency, hfe Test, Data hold.

Q13000.....$149.00



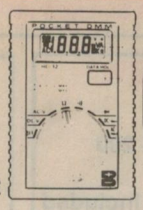
NEW In 1993

ROTARY TYPE AUTORANGE BAR-GRAPH DMM HC-889

- Safety compiled design
- The smallest compact hand held autoranging BAR-GRAPH DMM
- Automatically range and function annunciation on LCD.
- Hold / Memory mode for realitive measurements.
- Extended 20M ohm range, hFE diode checker
- çcontinuity detection with 4KHz audio drive signal
- Low battery detection & display warning annunciator.
- Convenient 9V battery operation
- Full scale of 40 pcs Bar display.

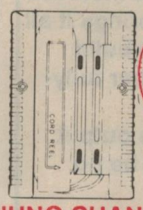
DISPLAY: 3 1/2 DIGIT
DC VOLTAGE: 0-1000V
DC CURRENT: 0-10A
AC VOLTAGE: 0-750V
RESISTANCE: 0-20M OHMS
CONTINUITY TEST, DIODE TEST,
DATA HOLD, TR HFE GAIN,
AUTO RANGE DMM WITH BAR GRAPH

Q13040.....$89.95



Front

Small & light for your top pocket.



Back

NEW In 1993

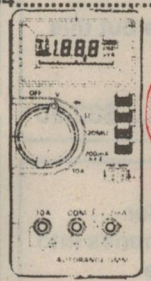
HUNG CHANG POCKET PERSONAL DIGITAL MULTIMETER Model HC-32

- Custom designed 80-pin LSI chip to achieve a low overall component count, ensuring long term stability and accuracy.
- New LCD display with anniniators for functions, unit, polarity, decimal point and low battery indicator.
- Rotary pocket type.
- Auto ranging polarity.
- Overranging indication on all ranges
- Measurement ranges (DCV, ACV, Resistance & Continuity Check, Diode Check 200mA DC/AC)
- Data hold switch to fix the reading.

SPECIFICATIONS:

- Operation System: Integration
- Display: 3 1/2 digit LCD
- Range Selection: Full autoranging system
- Sampling Time: 0.5 seconds
- Power requirement: 1.5V (A.A.A) x 2 battery
- Operating environment: 0°C~40°C
- Dimensions: 10cm (h) x 7cm(w) x 1.5cm (d).

Q11264.....$49.00



NEW In 1993

HUNG CHANG MULTI-TESTER DM301

- 3 1/2 Digit, Basic Accuracy DMM
- Low Cost, Amazing Quality, Vane pocket size.
- Safety Designed-Compiled to UL1244, VDE 0411
- Overload protection
- Diode Check

SPECIFICATIONS:
Display: 3 1/2 digit LCD. 0.5 height, with polarity.
Overrange Indication; 3 least significant digits blanked.
Maximum Common mode Voltage: 500V peak
Operating environment: 0 to 50°C
Power: 9V alkaline or carbon zinc cells
Dimensions: 128mm x 75 x 24mm

Q13050.....$49.95

NEW In 1993



HUNG CHANG DIGITAL MULTIMETER HC-31

- Custom designed 80-pin LSI chip to achieve a low overall component count, ensuring long term stability and accuracy.
- New LCD display with annunciators for functions, unit polarity, decimal and low battery.
- Rotary pencil type
- Auto ranging and auto polarity.
- Convenient one hand operation by connecting the alligator clip.
- Measurement ranges (DCV, ACV, Resistance and Continuity Check, Diode Check).
- Data hold switch to fix the reading.

SPECIFICATIONS:
Operation system: Integration

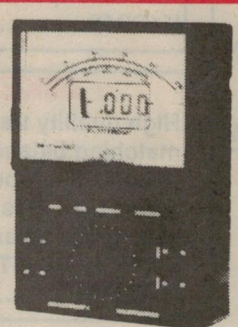
- Display: 3 1/2 digit LCD
- Range Selection: Full auto ranging system
- Sampling Time: 0.5 seconds
- Power requirement: 1.5V (A.A.A) x 2 batteries
- Operating Environment: 0° ~ 40°C
- Dimensions: 170mm x 35mm x 21mm.

Included with the HC-31:

- 1 Alligator crp
- Long Pin tip
- Carrying Case
- 2 A.A.A batteries
- Instruction manual

Q11270.....$49.00

GET THE BEST OF BOTH WORLDS WITH THIS ANALOGUE DIGITAL MULTIMETER



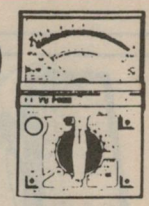
ANALOGUE / DIGITAL MULTIMETER

- HC - 505DB 3 1/2 DIGIT
- Basic accuracy: 0.5%DC
- DC Voltage: 0 - 1000V
- DC Current: 0-10A
- AC Voltage: 0 -750V
- AC Current: 0 - 10A
- Resistance: 0 - 20M ohms
- DC AC DMS:-45dB - +50dB
- Temperature: -20°C -1200°C
- AC Freq Spread: 50 Hz - 2KHz

Continuity Test, Diode Test.

Q13020.....$169.00

TRIED AND TESTED



ANALOGUE WORKHORSE

- Fuse and Diode protection
- hFE measurements 0 - 1000 (By x 10 range)
- Mirror scale for more accurate reading.

RANGES

- DC Voltage: 0 - .1, 0.5, 2.5, 10, 50, 250, 1000V. (20k ohm/v)
- AC Voltage: 0 - 10, 50. 250, 500V, 1000V (8kohm/V)

DC Current: 0-0.05, (50uA) 2.5, 25, 250mA

- Resistance: 0-2K, 20K, 2M 20M ohm
- Load Current: 0-150uA, 15mA, 150mA
- Load Voltage:0-3V
- Volume Level: -10- + 22dB - + - 62dB
- DC Current Amplification Factor: (hFE) 0-1000

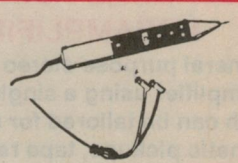
ACCURACY

- DC Voltage & Current: Within +/-3% f.s
- Resistance: Within =/-3% 0f arc.
- Battery: 1.5V (um-3) 2pcs. 9V (oo6p) 1 pc
- Fuse: o.5A, 5O x 20mm
- Diode: 4148 x 2
- C.C: 0.04uff x 50V
- Size: 147 x 99 x 57mm
- Weight: 400g approximately

Every Tool box should have one

Q11020.....$59.95

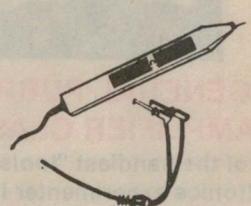
LOGIC PROBES



LOGIC PROBES

- Useful for TTL or CMOS has high and low indicator leds and also with pulse memory.
- This is a very handy tool for the hobbiest or serious technician for tracing those hard to find faults on logic boards.

Q11272.....$29.95



LOGIC PULSER

- Can be used directly to inject a signal into logic circuits without removing IC
- Compatible with TTL, DTL, RTL, HTL, MOs and CMOS.

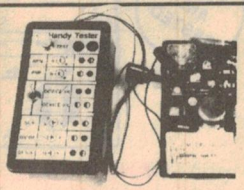
Q11274.....$49.95

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KITS ARE BACK!

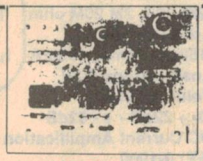
SLOWLY BUT SURELY WE ARE INTRODUCING OUR NEW KIT RANGE!



TRANSISTOR TESTER

Have you ever desoldered a suspect transistor only to find that it checks OK? trouble shooting exercises are often hindered by this type of false alarm, but many of them could beavoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept. '83) 83TT8

K10080.....$22.95



BALANCED INPUT DIFFERENTIAL PREAMP

This versitile little preamp has a host of applications in the audio-and-beyond range, not the least of which would be as a balanced mic preamp.

(ETI 461 Dec'82 ETI)

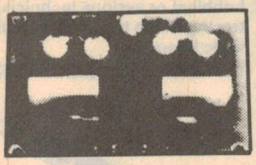
K10070.....$19.95

GENERAL PURPOSE PREAMPLIFIER

A general purpose stereo preamplifier using a single LM382 IC which can be tailored for use with magnetic pickups, tape recorders, and microphones by changing a few components

(ETI445) (ETI July '76)

K10055.....$14.95



GENERAL PURPOSE AMPLIFIER CLASS B.

One of the handiest "tools" for the electronics experimenter is a genuine purpose audio amp. This module will work from a wide range of supply voltages, has very good sensitivity, is robust, reliable and easy to build too!

(ETI 453) ETI April '80)

K10065.....$14.95

PLAYMASTER 300W AMPLIFIER

This module will deliver up to 200 watts into an 8ohm load. Comprehensive protection is included and a printed circuit board brings it all together in a rugged easy-to-build module. It can be built in either fully-complementary or quasi-complementary versions, so output transistor shortages should be no problem at all.

(80pa6) (EA July '80)

K10085.....$109.00



50W AMPLIFIER MODULE (ETI 480)

Use these high performing modules in band amps, P.A even HiFi's. Very simple to build and work because everything's on the one pcb. Heatsink optional extra

K10040.....$27.95

100 W AMPLIFER MODULE (ETI 480)

Similar to the above module but this one is 100 watts of power. Heatsink optional extra

K10045.....$32.95

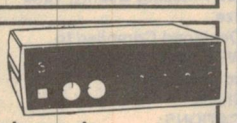
MIKE PRE AMP

High quality transformers for matching balanced microphones into unbalanced inputs are quite expensive. This simple preamplifier will accept balance inputs directly.

(ETI May '77, ETI 449)

K10060.....$11.95

DISCOLITE



This kit makes your lights do amazing things. With 4 light channels controlled by 4 separate audio channels. Eg. Forward, reverse, auto reversing chaser patterns, alternating light patterns, adjustable rate for light patterns, simultaneous strobe on all four channels. Plus many more features! (Sil Chip July 1988)

K10130.....$155.00

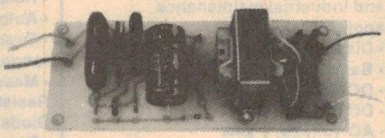


SOLAR GENERATOR

The ETI-569 Solar charger is designed to charge any standard 12 V lead acid car battery in any area where mains power is unavailable. It is ideal for remote data acquisition stations, caravans and boats.

Of coarse there are other soloar chargers around, but these are extremely expensive. With the ETI-569 the emphasis is on simplicity and cheapness.

K10005.....$13.95



ELECTRIC FENCE KIT

Main to battery powered, this electric fence controller is both inexpensive and versitile. Based on an automotive ignition coil, it sould prove an adequate deterrent to all manner of livestock. Additionally it's operation conforms to the relevant clauses of Australian Standard 3129. (EA Sept. '82) 82ef9

K10110.....$23.95



ELECTRIC FENCE CONTROLLER

Restore the discipline to the farm or allotment with this new electric fence controller. It features higher output power and lower current drain than the previous design.

(EA Dec. '85, 85ef11)

K10115.....$61.95

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ROD IRVING ELECTRONICS

HEATSHRINK TUBING

Cover up dangerous live wires and strengthen joints with heatshrink tubing. Comes in a large number of different sizes.

PRICES PER METRE

PHS 1.5 mm (1.5mm)



H11740	Red	$2.50
H11750	Blue	$2.50
H11760	Black	$2.50
H11770	White	$2.50
H11780	Clear	$2.50

PHS 2.5 mm (2.5mm)

H11741	Red	$2.50
H11751	Blue	$2.50
H11761	Black	$2.50
H11771	White	$2.50
H11781	Clear	$2.50

PHS 3.5 mm (3.5mm)

H11742	Red	$2.95
H11752	Blue	$2.95
H11762	Black	$2.95
H11772	White	$2.95
H11782	Clear	$2.95

PHS 5 mm (5mm)

H11743	Red	$3.25
H11753	Blue	$3.25
H11763	Black	$3.25
H11773	White	$3.25
H11783	Clear	$3.25

PHS 7 mm (7mm)

H11744	Red	$3.50
H11754	Blue	$3.50
H11764	Black	$3.50
H11774	White	$3.50
H11784	Clear	$3.50

PHS 10 mm (10mm)

H11745	Red	$4.50
H11755	Blue	$4.50
H11765	Black	$4.50
H11775	White	$4.50
H11785	Clear	$4.50

PHS 13 mm (13mm)

H11746	Red	$5.50
H11756	Blue	$5.50
H11766	Black	$5.50
H11776	White	$5.50
H11786	Clear	$5.50

PHS 16 mm (16mm)

H11747	Red	$5.95
H11757	Blue	$5.95
H11767	Black	$5.95
H11777	White	$5.95
H11787	Clear	$5.95

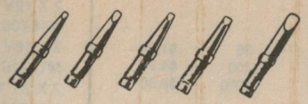
PHS 20 mm (20mm)

H11748	Red	$8.50
H11758	Blue	$8.50
H11768	Black	$8.50
H11778	White	$8.50
H11788	Clear	$8.50

PHS 25 mm (25mm)

H11749	Red	$11.50
H11759	Blue	$11.50
H11769	Black	$11.50
H11779	White	$11.50
H11789	Clear	$11.50

SAVE ON SOLDER TIPS!



WTCPN SOLDERING TIPS

All Weller PT Series soldering pencil tips have been plated with an exclusive process that deposits protective coatings. The high conductivity copper tips are iron plated and then nickel plated on non working sufaces. The working suface is then pretinned. The chrome plating of the tip prevents oxidation of the iron plating which cause freezing of the tip in the pencil. The plating also prevents solder "creep-up". Weller's "temperature sensing" tips have a small ferromagnetic sensing element attached to the tip shank. the sensing elecment is coded with a number to indicate idle temperaure in hundreds of degrees F. Thus a simple change of tips is all that is necessary to adapt the tool to an entirely different temperature range.

Cat.No	Size	Temp	Description	Weller No
T12502	• 1.6mm	370°C	Screwdriver	PTA7
T12503	• 1.6mm	430°C	Screwdriver	PTA8
T12505	• 1.6mm	370°C	Spade.....	PTAA7
T12506	• 1.6mm	430°C	Spade.....	PTAA8
T12508	• 2.44mm	370°C	Screwdriver	PTB7
T12509	• 2.44mm	430°C	Screwdriver	PTB8
T12511	• 2.4mm	370°C	Spade.....	PTBB7
T12512	• 2.4mm	430°C	Spade.....	PTBB8
T12514	• 3.2mm	370°C	Screwdriver	PTC7
T12515	• 3.2mm	430°C	Screwdriver	PTC8
T12517	• 3.2mm	370°C	Spade.....	PTCC7
T12518	• 3.2mm	430°C	Spade.....	PTCC8
T12520	• 5.0mm	370°C	Screwdriver	PTD7
T12521	• 5.0mm	430°C	Screwdriver	PTD8

ALL WELLAR TIPS ON SPECIAL THIS MONTH!

1-9	10+
$9.95	$8.95

NEW CHEAPER SOLDER PRICES! 25% MORE PRODUCT THAN OUR OPOSITION FOR THE SAME PRICE.

60/40 Resin Corded absolute top quality.

SOLDER ROLLS *25% More

T31000	.71mm 250g	$8.95
T31002	.71mm 500g	$15.95
*T31010	.91mm 250g	$7.95
T31012	.91mm 500g	$14.95
T31020	1.6mm 250g	$7.50
T31022	1.6mm 250g	$13.95
T31030	.71mm 1mtr	$1.50
T31032	.91mm 1mtr	$1.50
T31034	1.6mm 1mtr	$1.50

CALL THE RIE BULLETIN BOARD NOW ON (03) 562 7903 FOR THE LATEST SPECIALS, INFORMATION SERVICE AND SUPPORT.

RIE

WELLER SOLDERING STATION

Save $40 this Month!



with temperature controlled soldering iron.

A tramsformer powered soldering station, complete with a low voltage, temperature controlled soldering pencil. The special Wellar "closed loop" method of controlling maximum tip temperature is employed, thereby protecting temperature sensitive components while the grounded tip protects voltage and current sensitive components. The soldering pencil features a stainless steel heater construction, a non-burning silicon rubber cord and a large selection of iron plated tips in sizes from 0.8mm diameter to 6.0mm diameter with a choice of tip temperature of 315° C/600°F, 370° C/700° F and 430° C/800°F.

T12500 Usually $179.00 This month only $139.00

UNBELIEVABLE PRICE BREAKTHROUGH!

DO YOUR BUSINESS OVER THE PHONE.

MOTORLOA 7500H HAND HELD MOBILE PHONE



The answer is in the palm of your hands with the NEW Motorola Mobile Phone. You will never miss another important call!
Ideal phone for people on the move, it's attractiive, light weight, and reliacble communication. With an amazing 90 minute talk time.
Constists of :

- 7500H Cellular phone
- One battery
- Desktop charger.

CatNo. A40000... R.R.P $877.00

OUR PRICE...$799.00

HANDS FREE CAR KIT TO SUIT 7500H

Everything you need for hands free car operation.
Easy to install
A40001.....R.R.P $575.00



OUR PRICE.... $395.00

Your totalMobile Phone package for under $1200.00 and with telephone rental for as little as $10.00 per month
NOW IS THE TIME TO BUY!!
These phones are ready to go, if you order them mailorder. Tax Exemption is available if applicable to your use.

PHILIPS TRIMMER CAPACITORS

• Plastic film , top adjust, colour coded 808 series



	Range	Colour	O.S	1-9	10+
R15201	1.8-15pF.....	Blue	10mm	$1.25	$1.10
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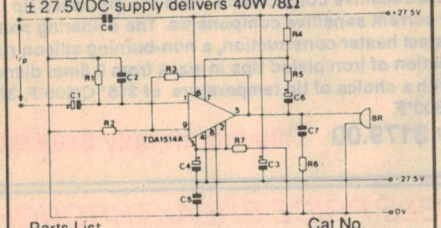
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TDA1514A

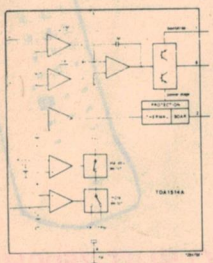
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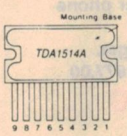
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Parts List		Cat No.
R1,3	Min Res 22kΩ	R10062
R2	Min Res 680Ω	R10044
R4	Min Res 82Ω	R10033
R5	Min Res 150Ω	R10036
R6	Min Res 3.3Ω	R10016
R7	Min Res470k	R10078
C1	PC Elect 2.2µF 100V	R15427
C2	Ceramic 220pF	R15328
C3,4	PC Elect 47µF 63V	R15525
C5.8	Green Cap 0.47µF	R15168
C6	PC Elect 220µF 35V	R15543
C7	Green Cap 0.022µF	R15152

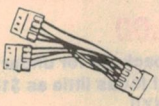




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H12030	BOLT 3 X 20mm	25	$1.45
H12033	BOLT 3 X 20mm	200	$6.20
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H12203	NUT 3mm HEX	200	$6.95
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H12303	WASHER 3mm FLAT	200	$4.65
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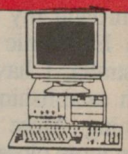
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THE SERVICEMAN

Some first-hand experience at the technical training 'coal face'...

This month I want to open with a few words on a subject that has been dear to my heart for some years — technical training. A few weeks ago I was thrust into a part-time teaching position myself at short notice, and it gave me a new respect for trade teachers! I also have a somewhat embarrassing story from my own workbench, and a couple of short items from contributors — including one about wrongly-marked components.

Over the years, the number of apprentices taken on by the electronics service industry has been steadily falling. The cost of training new staff has become so great that few businesses can afford the luxury of employing untrained hands.

Through my association with TETIA, The Electronic Technicians Institute of Australia, I have been closely involved with establishing standards for technical training. More recently, I have become even more closely associated with technical training — in a 'hands on' sense, in fact. It all started this way...

A few weeks ago a friend of mine, who teaches in the local TAFE college, told me that the Head of School was looking for me. It was suggested that if I wanted to avoid being in the centre of a mushroom-shaped cloud, I should get myself down to the office as soon as possible.

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As it turned out, the panic was not as serious as first thought. All he wanted to know was "..would I be prepared to teach basic electricity to a class of would-be welders?"

It appears that the Federal Government had put up the money to train a group of young men in basic welding techniques, in the hope that an employer would take them on after graduation.

The College had two problems. One was that budget cuts had pruned their teaching staff to the bare bones, and there were no spare teachers available to take an extra class. The second worry was that 'regulations' limited part-time staff to only 20 hours a week, and this 40-hour course had to be completed within five days.

Both problems could be solved by taking on two part-time teachers, and I would help the solution by accepting one of the positions. "Would I? Could I? Please!"

Fortunately my workshop was not all that busy at the time, so I agreed. I asked for the morning session, since most of my customers arrive after lunch and having the afternoons free seemed like a good idea — at the time.

It wasn't until after everything was settled that I learned that the class was to start at 8.00am, and I would need to be there by 7.30am to get the equipment and teaching aids ready.

I haven't started work at that hour since I was on shift work as a callow youth in the 1950's. My worry wasn't so much about waking up on time, but more whether I would go back to sleep by 11.00am!

So, with my appointment confirmed, it was time to look at what I would be expected to teach. And at this point it would be as well to say a bit about the modern TAFE curriculum.

In the past, electricians and electronics specialists each learned the same basic theory, but taught in different ways in quite separate classes.

Similarly, electricians in each state learned the same material, but taught under different curricula. Ditto for radio and TV technicians.

All of this duplication and repetition was dreadfully wasteful of resources, and a few years ago the Federal Department of Education sponsored a 'Common Core Curriculum', based on simple modules which could be presented quickly and easily whenever there was a perceived need for that subject.

Until recently, a trade course in electronics required an apprentice to study 'Radio and TV' for three years, whether or not that course suited his employer's needs. Now, under the modularised system, an apprentice's course can be tailored to suit his employer's requirements. And individual modules will be available for post-trade retraining at any time during one's career.

Nowadays, a trade course consists of a total of 24 modules, each of 40 hours duration. Some modules are compulsory to all metal trades. These include workshop safety, first aid, and basic electricity. After these compulsory modules, a trainee undertakes a series of more detailed theoretical subjects, and finally an number of elective modules most appropriate to his particular branch of industry.

But back to my escapade. The module I was to teach was called NBB08, or National Broad Based module number 8. The module comprises eight sections, plus notes on electrical safety and electrical fires. The eight sec-

tions are (1) The electric circuit; (2) Circuit components; (3) Resistance; (4) Ohms Law; (5) Electrical power; (6) Series circuits; (7) Parallel circuits; and (8) Circuit protection.

On this occasion, all eight sections, together with two four-hour written and practical tests, had to be completed within five days, between Monday and Friday. This gave the students a really solid workout, and their eyes were hanging out by the end of the week.

I taught section-1 on Monday morning, section-3 on Tuesday morning, then took the first of the two tests on Wednesday morning. On Thursday I taught 'Series Circuits', and on Friday 'Circuit protection'.

Each of these four-hour sessions was broken up into approximately two hours of 'chalk and talk', and two hours of practical hands-on work with simple circuit components. The students were given plenty of time to ask questions and were encouraged to help each other, so long as this did not interfere with their own learning processes.

So — how did the exercise work out, both for me and for the students? Well, we got them through, but for some it was touch and go. The class consisted of nine young male students. Three were unwilling and hopeless; three were willing and hopeless, and three were unwilling because they knew it already.

It seems that if I had been an experienced teacher, I would have removed at least one of the first group on the first day. He was a disruptive influence all through the course, and was given to playing senseless practical jokes.

The second group was a different story altogether. Their eagerness was almost pathetic, and they often kept me back after class to explain points that they had missed earlier. They had great difficulty with such simple concepts as the resistor colour code. They were forever getting the second digit mixed up with the multiplier. And the tolerance band is better not mentioned!

One lad even had the greatest difficulty understanding the meaning of a 'series circuit'. He had six tries to connect an ammeter in circuit and got it wrong on five of them. (I didn't try for a seventh time. The disappointment if he had failed again would have broken his heart!)

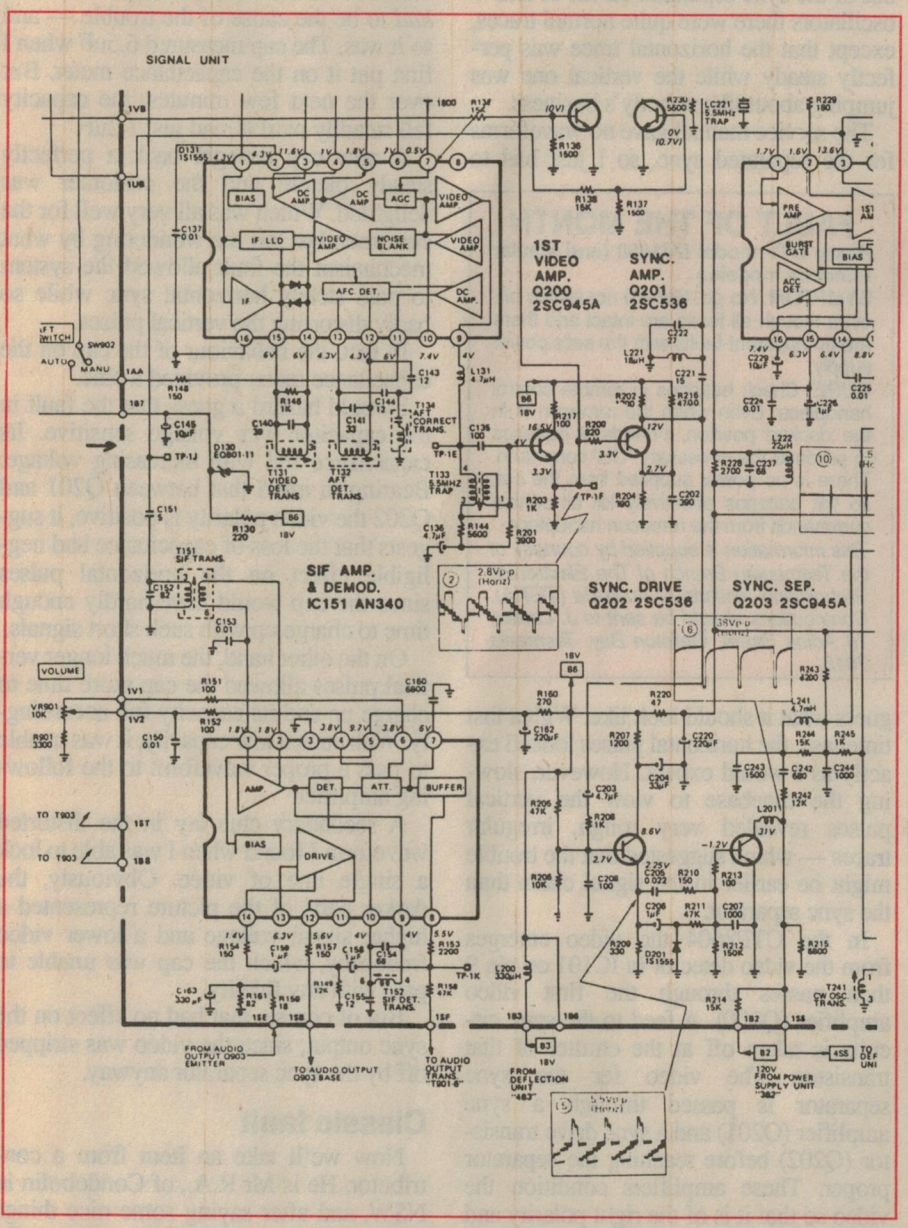
The final group had all done High School Physics, which covered most of the ground in this module. They got more benefit from my stories about practical servicing difficulties than they did from the reiteration of basic theory. Unfortunately, they wanted their 'welding certificate' and that was dependant on them completing this module. So they were bound to sit through what for them amounted to 40 hours of boredom.

Now, what about me? Well, I survived, but by the end of the week I was completely exhausted. I used to think that teachers had it easy, but now I know better.

Each night I put in about an hour going through the lesson for the next day. I had to be sure that I knew what it was all about, and to decide what teaching aids I would need to present it properly. Then next morning, I had to be on board at least half an hour before class started, to get ready all the teaching aids and the equipment needed for the morning's work. (Unfortunately, much of this equipment is useless out of the classroom, but still 'disappears' if not kept locked in the equipment store.)

I had no difficulty in actually teaching the subject. After 40 years in the trade, basic electricity becomes pretty thoroughly ingrained. Where I did have trouble was through getting into what I call my 'flywheel mode'. I would start at the beginning and work my way through almost automatically. If nobody asked a question, there'd be no trouble.

But if one of the students was a bit slow and asked about something from 10 minutes back, I found considerable difficulty in remembering what it was I was talking about then. I've heard of one teacher who was called 'Stylus', because



Here is the video processing and sync separator circuitry for a Sanyo CTP8604 colour TV, which is the subject of our Serviceman's main story this month. The set concerned had a strange vertical locking problem.

he was like a phono record: once in the groove, he couldn't change his tune. Now I know why...

When teaching one subject repeatedly, it must be very tempting to develop a patter that can be delivered accurately over and over again, even when your mind is on something else. Although I was delivering each subject only once, I was still tempted to develop that kind of style.

After that experience, I now have a much better appreciation of our TAFE teachers and what they are doing.

The past 10 years have brought dramatic changes to technical and trade training. Those of us who sat through boring lectures 20 or more years ago would not recognise the modern system. The system of Training Modules allows a student to see much more clearly what it is he's learning, and where it fits into the overall scheme of things. It also helps the teachers, by clearly defining exactly what it is that the student has to learn.

After all that, I've decided that I wouldn't want to be a teacher for more than a few days at a time. At the same time, I've got a new respect for those who have the job of training the next generation of technicians.

Oh — by the way, the teachers at the college where I was working seemed to appreciate having a bit of 'outside influence' in the staff room. They find it all too easy to lose touch with the industrial 'coal face', and talking with front-counter people helps them keep up to date with the problems brought on by new technology.

Bouncing Sanyo

Now, with that story out of the way, I can get on to a bit of practical servicing from my own workshop. It's a story about pride coming before a fall. I thought I knew the answer before I started, but I was promptly re-informed. It happened like this...

I was called in to service a Sanyo model CTP8604 colour TV recently. The symptoms were severe vertical bounce and occasional rolling.

The fact that there was no sign of horizontal instability was significant, and pointed to the vertical integrator circuit as the site of the trouble.

Horizontal and vertical sync pulses are mixed together when they emerge from the sync separator. They have to be further separated by passing them through a differentiator to extract horizontal pulses and an integrator to extract the vertical pulses.

In the case of this Sanyo, I felt confident that the vertical pulses were being lost in either the resistor or capacitor that comprise the integrator.

The bounce was caused by weak sync and the roll by occasional loss of sync. The fact that the horizontal sync showed no sign of any problem seemed to indicate that the pulses must be OK as they leave the sync separator. So I spent a lot of time finding, then removing the relevant components. But it was all a waste of time, since they tested perfectly normal. This left me with a problem, since there was no other logical source for the trouble.

My oscilloscope showed what at first appeared to be a perfectly normal trace out of the sync separator. At the H and V oscillators there were quite normal traces, except that the horizontal trace was perfectly steady while the vertical one was jumping about like nobody's business.

The service manual gave no waveforms for the separated sync, so I just had to guess what it should look like. With a fast timebase, the horizontal pulses looked exactly as I would expect. However, slowing the timebase to view the vertical pulses revealed very rough, irregular traces — which suggested that the trouble might be earlier in the signal chain than the sync separator.

In the CTP8604 the video emerges from the video detector in IC101 on pin 9 then passes through the first video amplifier (Q200). A feed to the sync circuits is taken off at the emitter of that transistor. The video for the sync separator is passed through a sync amplifier (Q201) and a sync drive transistor (Q202) before reaching the separator proper. These amplifiers condition the video so that it is of the right polarity and amplitude before separation.

Working backwards, I traced the video from the sync separator to the sync drive to the sync amp and back to the first video amp. At the separator output I found normal horizontal sync and rough, irregular vertical sync. But at the base of the separator transistor (Q203), I found very unusual video. I could lock a single line to view a rather distorted waveform, but no way could I get any sort of locked waveform at the vertical frequency.

The result was the same at the sync drive, albeit at a lower amplitude — which was only to be expected. The real surprise came when I looked at the output of the sync amplifier (Q201). The video here was perfect, allowing a solid lock at either horizontal or vertical frequency.

The only component between the first and second sync amplifiers was C203, a 4.7uF 25 volt electrolytic capacitor. This *had* to be the cause of the trouble — and so it was. The cap measured 6.5uF when I first put it on the capacitance meter. But over the next few minutes, the capacity fell steadily until it read just 1.2uF.

A new cap brought back a perfectly steady picture and the customer was delighted. Which was all very well for the customer, but left me wondering by what mechanism the fault allowed the system to pass steady horizontal sync while so badly distorting the vertical pulses.

In fact, the behaviour of the cap on the capacitance meter provided a clue.

I would hazard a guess that the fault in the capacitor was voltage sensitive. Its capacitance fell with increasing voltage. Bearing in mind that between Q201 and Q202 the video polarity is positive, it suggests that the loss of capacitance had negligible effect on the horizontal pulses since the cap would have hardly enough time to charge up with such short signals.

On the other hand, the much longer vertical pulses allowed the cap more time to charge up and its capacity fell accordingly. With such a low capacity, it was unable to pass a proper waveform to the following amplifier.

A secondary clue lay in the distorted waveform I found when I was able to lock a single line of video. Obviously, the darker parts of the picture represented a higher signal voltage and a lower video frequency, which the cap was unable to pass with any fidelity.

But of course, that had no effect on the sync output, since the video was stripped off by the sync separator anyway.

Classic fault

Now we'll take an item from a contributor. He is Mr R.A., of Condobolin in NSW, and after saying some nice things about the magazine and this column, he refers back to several stories that have appeared in recent months:

FAULT OF THE MONTH

Sharp CTV model DV1600 (and similar remocon models.)

SYMPTOM: No go. Set will not switch on, even though all fuses are intact and there are no apparent faults with the set's power supply.

CURE: Check batteries in remote control handpiece. Even when the remocon is in the 'docked' position, it needs its batteries to produce the necessary 'ON' command. There is no power supplied from the set, so flat batteries effectively kill all control commands from the remocon handpiece.

This information is supplied by courtesy of the Tasmanian Branch of The Electronics Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

I have been reading your magazine for most of my adult life, and having been retired now for some 20 years, still manage to keep up to date with things by consuming your column each month.

Since I had retired before colour TV started, my introduction to this technology was by way of my own Philips 63cm model, fitted with the KL9A chassis. And since this model has featured frequently in the column in recent months, I realised that sooner or later I would be making a safari into the unknown depths behind the screen.

Last year, with but few preliminaries, our picture disappeared. And coming over all technical, I dived at once into the area that seemed to contain the horizontal output circuits.

I soon determined that it was not the tripler, nor the line output transistor. So with the aid of several inches of desoldering braid, I removed the next suspect, the line output transformer.

After the various stories about this chassis that have appeared recently, I was not at all surprised to find a small black spot on the overwind. It had been hidden behind the heatsink for the 2SD350A line output transistor. Since replacing the faulty transformer, all had been well until just before Christmas. Then patterned flashes began to occur, followed by short duration blackouts.

Being busy with Christmas preparations at the time, and since the occurrences were not all that frequent, I put off attending to the set for a time. Fortunately, nothing dramatic happened during the annual visit of the grandchildren between Christmas and New Year.

In any case, we had the loan of a set to keep the littlies amused, while we oldies watched the cricket on the Philips. We had never been a two-set family, but this experiment proved so successful that we resolved to buy a second set at the earliest opportunity.

This was a fortunate decision, because hardly had the dust settled after the family's departure than the Philips refused to start up. A hurried trip to our friendly local store got us the 38cm set we had chosen and with it, I had bought a few hours (or days) grace to deal with the new problem.

When I got back to thinking about it, I decided for some reason that it would be another line output transformer that was needed. This was duly obtained and fitted, and hey presto, we were back in business.

At this point, I had occasion to phone a close friend — who grumpily informed me that he was looking at a black screen and was about to take his TV to town for exploratory surgery.

Of course, I immediately offered him the loan of our new 38cm and this was gratefully accepted, since he was about to leave for Sydney for a week or two and his family would be without TV until he returned.

Can you guess what happened next?

That's right! Next morning our Philips was again in retirement — with the same old trouble. Well, not QUITE the same old trouble, since the power supply had begun hiccupping. But this time things were really desperate, because the cricket was about to start. I began to remove and test everything around the deflection circuits, and I set aside anything that wasn't 100%. It was while I was in the process of looking for the right dobs of solder to suck, to get at C567, that I discovered one of them was missing!

The end of the lead was sticking out of the hole and there was enough solder left on the lead to stop me pulling it through the board after I had released the other end. But it was a classic dry joint, slightly blackened from the arcing which had apparently caused the flashing we had seen on the screen. So there was nothing wrong with the line output transformer replaced most recently. It was just by chance that the dry joint elected not to show up until after I had fitted the tranny!

After cleaning up the board and the leads on C567, I replaced the capacitor and carefully resoldered it back into circuit. There has been no further trouble with the Philips, and you might be interested to know that our team won. (The cricket, that is!)

So there it is. Beware the little black hole! I haven't come across any more of those transformer failures since the original stories, but I have heard of others who have. It seems strange that just one type of transformer should fail so often, in such a characteristic way.

Surprising cause

Now we come to another contributor's story, which carries a different kind of warning. This is one of those 'it never should have happened' yarns, and will alert us to a possible answer to one of those seemingly insoluble problems. It's from G.C., of Uki in NSW:

Here is an alert to all service staff and others engaged in the construction of electronic gear.

My job includes repairing inverters, and the company also manufactures a small sine wave inverter. In the early stages of the development of this line, the circuit used an auto-start configuration based on an EA design. This method involved sensing the forward voltage drop

Continued on page 126



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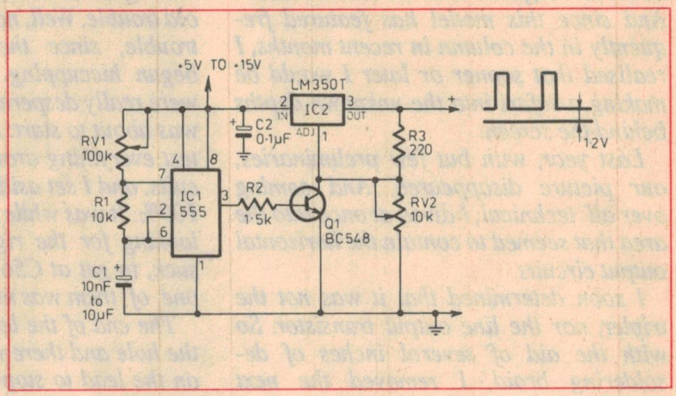
Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

High current pulses

Since I'm always looking for a new way to obtain high-current pulses for flashing lamps and driving motors, I have recently been experimenting with ways to switch the output of the LM350T on and off. Since the output voltage of this chip is fully adjustable, a circuit which switches its output on and off provides a variable-amplitude power pulse generator.

The diagram shows one way to switch the LM350T (IC2) between its minimum output of about 1.2V and the voltage set by RV2. In operation, the 555 timer (IC1) forms an oscillator which turns transistor Q1 on and off. When Q1 is on, the output of IC2 falls to its minimum 1.2V level, as the voltage adjust terminal (ADJ) is shorted to ground through Q1's collector-emitter path. When Q1 is off, the LM350T functions normally.



Though this circuit has many applications, I've found it to be particularly effective as a flasher for incandescent lamps. Keep in mind other applications for the circuit. For example, it can deliver adjustable-rate pulses to a DC motor, thus serving as a speed control. It can also be connected to a large speaker and used as an attention-getting warning tone generator.

Charles Hill,
Suva, Fiji **$40**

Automatic turn-off switch

After leaving on my soldering iron overnight numerous times, I needed a switch so that it would turn off automatically. The circuit shown does this, and can also control anything else of a similar nature. It turns off the device after about 18 minutes, and a LED (LD1) gives a warning flash for 4 minutes before it turns the device off.

When power is applied, pushbutton PB1 needs to be pushed to reset IC3 (4040), a 12-stage binary ripple counter — otherwise IC3 could be anywhere in its counting cycle.

PB1 activates the 'master reset' of IC3, via the 10uF capacitor and 100k resistor, by sending its pin 11 high. This resets all outputs Q0-Q11 low — and, while PB1 remains pressed (keeping pin 11 high), they remain low irrespective of the state of the active low clock- pulse input (pin 10).

Several of these IC3 outputs are connected to IC4 (4032), a triple 3-input NAND gate. The low outputs on Q1, Q8 and Q9 send the output of IC4a high, which keeps LD1 off via the BC558 transistor Q1; while the low on Q10 has two effects. Via pin 1 of IC4b, it sends pin 9 high, which prevents the 555 timer (IC2) from being reset; and via transistor Q2, it switches on the triac optocoupler U1 (MOC3021), which controls the 240V power to the main circuit via triac TR1 (MAC320A8FP).

As shown in the schematic, the 555 (IC2) is set up to operate in its astable mode, with a period of approximately 1s. The low-to-high pulse from its output at pin 3 is used to clock pin 10 of IC3.

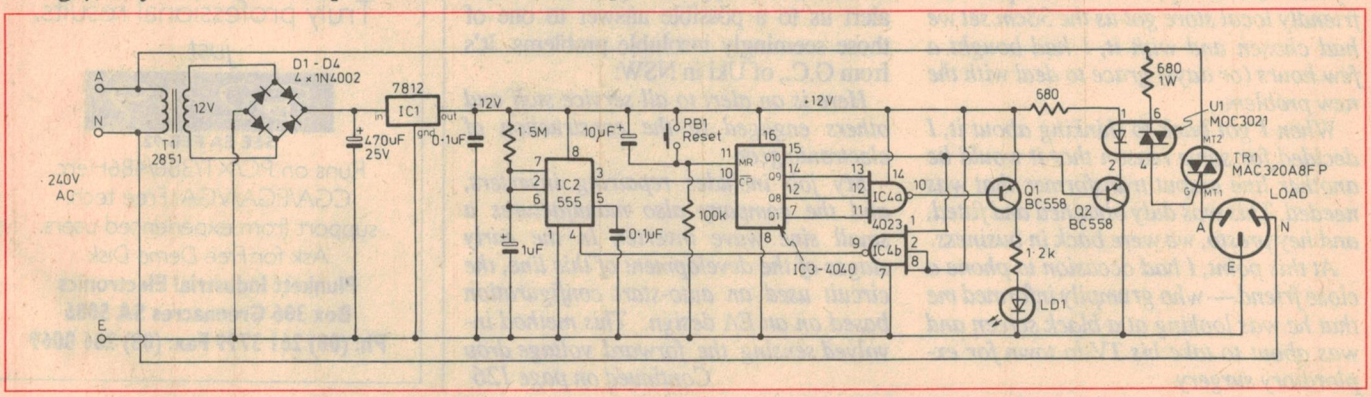
Once IC3 has reached a count of 769 (about 13 minutes), its outputs Q1, Q8 and Q9 are all high. These three highs cause IC4a to go low and turn on the warning LED. As the count continues, output Q1 changes its state every 2s, so Q1 and LD1 are turned on and off.

This flashing continues until a count of 1024 is reached (about 17 minutes), when output Q10 goes high and turns off transistor Q2, optotriac U1, triac TR1 and the device under control. The high also causes IC4b to go low, which is applied to pin 4 of IC2 to stop the timer counting.

The device can be turned on again, or kept on by simply pushing PB1 to restart the cycle.

The low power is derived from transformer T1 (2851), the bridge rectifier D1-D4 (1N4002) and a 7812 3-terminal regulator. The mains power is directed through U1 and TR1 to the load socket. The usual care needs to be taken with the potentially lethal 240V.

Colin Irwin,
West Chatswood, NSW **$45**



Receiver modules

When designing HF direct conversion CW transceivers, it is useful to have a standard receiver module which can be made to work on various bands with only slight modifications.

The standardisation of equipment around a common module makes construction and service easier, and reduces debugging/optimisation time.

The following module is designed to work with VFO/VXO/crystal controlled CW transmitters, operating on the lower bands. Both 80 and 40m transceivers have been successfully constructed around this module.

The direct conversion detector uses the CA3028 IC whose gain is controlled by RV1, which should be set to maximum voltage on pin 7, in the first instance. CV1 and C2 (not required on 40m), together with L1, form a tuned circuit set to the required band. A BC548 (Q1) audio preamp boosts the signal for the 741 opamp (IC2), which amplifies the signal for the 600 ohm headphones. These phones can be replaced by a 1k:8 ohm transformer and low-Z headphones.

The value of the aerial coupling capacitor C1 depends on the band; the prototypes used 220pF for 80m and 5pF for the 40m version. Strong broadcast stations on the 41m shortwave band may overload the CA3028A detector (IC1) in the 40m receiver.

This can be remedied by paralleling CV1 with a 220 ohm resistor, which will have little effect on the strength of the desired signal.

The coil L1 is wound on a 9mm 4C6 ferrite toroid, Philips 4322 020 97170, using 0.4mm gauge enamelled copper wire for both windings. The number of turns for the primary, followed by the secondary, are given in the following table, which shows the details of the front-end tuned circuit for two popular bands.

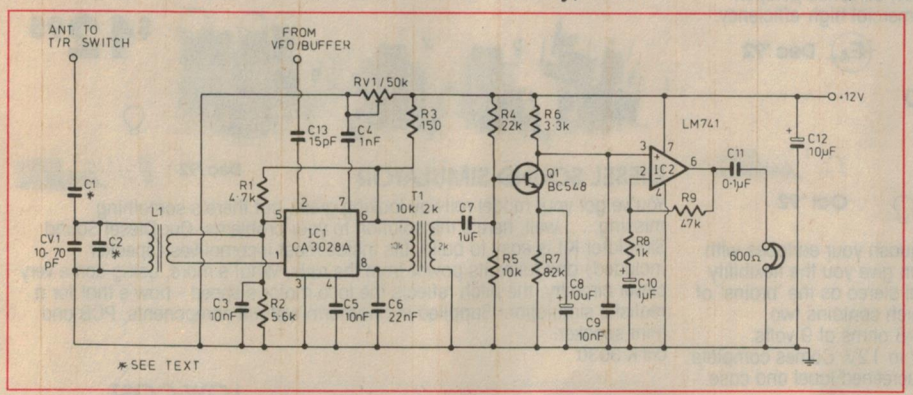
	L1	C1	C2
80m	17:5	220pF	220pF
40m	26:5	5pF	0

This receiver needs a signal from the transmitter oscillator to operate, so the transmitter may need to be modified if it uses a keyed crystal/VXO oscillator; key the driver and/or PA instead. Capacitor C13 should be connected to the output of the buffer; its low value ensures negligible drop in RF power output on transmit.

To provide the 800Hz T/R frequency offset, the VFO or crystal oscillator must be shifted down 800Hz on *transmit* only. Alternatively, the VFO or VXO may be manually adjusted by zero-beating your receiver with the station with whom you are in contact, just before it's your turn to transmit.

Transmit/receive switching can be handled by either a keyed DPDT relay, or a panel-mounted toggle switch. To improve the selectivity of this receiver, an 800Hz bandpass filter can be included between C11 and the headphones.

Peter Parker,
Bentley, WA **$40**



DREAMED UP A GREAT IDEA?

If you have developed an interesting circuit or design idea, like those we publish in this column, why not send us in the details? As you can see, we pay for those we publish — not a fortune, but surely enough to pay for the effort of drawing out your circuit, jotting down some brief notes and popping the lot in the post (together with your name and address) and send them to Jim Rowe at -

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CURRENT RATING:

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M-2010	8A	20A	25A
UPGRADED M-2010	15A	20A	25A

For those who remember the original Powermaster, the addition of a 20A panel meter to the kit plus provision for an optional 12V cooling fan will make even higher power configurations possible with perfect safety. On the cosmetic side, the supplied case is now an attractive black powder-coated steel unit - an advance over the previous bare aluminium box. Other improvements include: A front-panel overload protection reset switch and a primary slow blow fuse with finger proof fuse holder. The kit includes all components (excepting those that depend on your choice of transformer), hardware and a pre-punched silk-screened chassis.

Cat K-3400

EA Jan'93

DISCO STROBE KIT

Cat K-3155

$109

Just the thing for your do-it-yourself disco outfit! This reliable kit provides a high-energy flash of white light which you can vary from 1-10 flashes/second. It's triggered by either an external source or its own internal oscillator and has both input & output trigger connectors, so that any number of these units can be linked to flash in sychronisation. Comes with all components, hardware, PCB, deluxe plastic case, screened perspex front panel, linear 100mm Xenon tube and a commercial high-efficiency reflector.

EA Dec '92



MINI STEREO AMPLIFIER

Cat K-5008

$22.95

Oct '92

Sick of your personal stereo's limitations? Why squash your earlobes with a pair of headphones when this inexpensive kit can give you the flexibility of a home hi-fi on your desk! It uses your personal stereo as the 'brains' of the operation and uses a tiny 8-pin DIL device which contains two amplifiers and is capable of delivering 1 watt into 8 ohms at 9 volts. What's more, supply voltage can range from 1.8V to 12V. Comes complete with all components, PCB, hardware, front panel screened label and case.



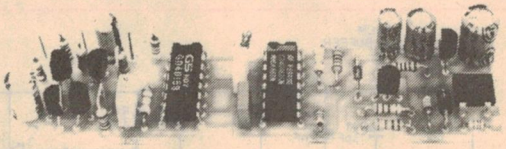
MOTOR SPEED CONTROLLER

Cat K-3085

$46.95

Sept '92

An easy-to-build kit designed to regulate the speed on heavy-duty power tools. It's ideal for circular saws, electric drills, lawn edgers, jig-saws, sanders, grinders and other equipment rated at 5 amps with a 'brush' type motor. This improved design has a higher current rating and uses a Triac rectifier instead of an SCR. It also monitors the back-EMF voltage from the motor so, though the drill speed is controlled, it won't bog down when the going gets tough. Complete with deluxe pre-punched black anodised screened front panel, components, PCB and flush-mounted mains socket.



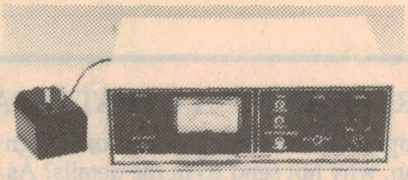
$12.95

DIESEL SOUND SIMULATOR

Dec '92

You've got your model railway looking great, but there's something missing... ...well, here's the solution to your problems: Our Diesel Sound Simulator Kit is easy to build, fits inside most locomotives (speaker included) and takes its power from the rails. What's more, using some very clever circuitry, the pitch reflects the loco motor's speed - how's that for a realistic simulation! Supplied in Shortform with all components, PCB and mini speaker.

Cat K-3030



LOW-COST AUDIO SWEEPER

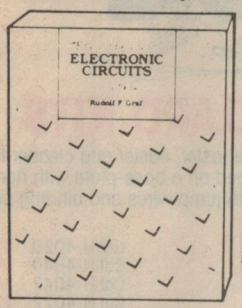
Cat K-7352

$109

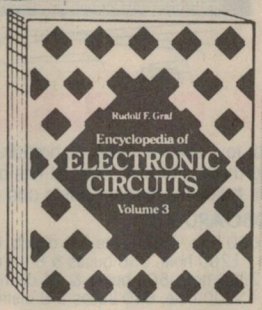
Here's a useful kit for audiophiles, sound experts, enthusiasts and anyone interested in sound. This very affordable audio test system analyses the performance (treble, mid and bass) of speakers, speaker enclosures filter circuits and room acoustics. It consists of a sweeping audio test signal generator and a metering amplifier which measures the results. Comes complete with a deluxe pre-punched front panel, plastic instrument case, PCB, hardware (including dB meter), components, mic. insert and plug pack.

EA Sept '92

BOOKS



Volume 2 Cat B-1758
$52.95



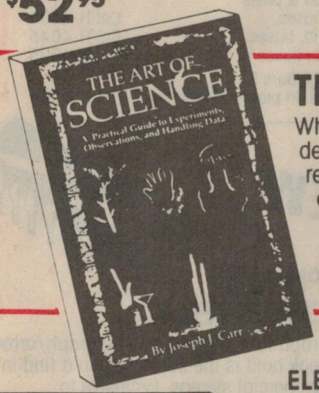
Volume 3
Cat B-1760 **$56.95**



Volume 4
Cat B-1762 **$59.95**

THE ENCYCLOPAEDIA ELECTRONIC CIRCUITS VOLUMES 2, 3 & 4

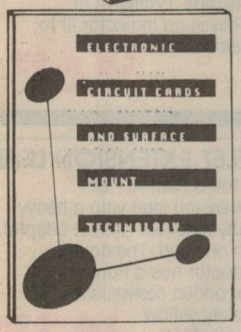
Essential reference material for the professional (or amateur) electronics technician. If you're looking for a circuit for a particular application, it's either in here or there's something very close. These volumes are also ideal as project idea-starters.



THE ART OF SCIENCE

Whether you're just starting out in electronics (or any other scientific field), or someone with decades of experience, this book will supercharge your thinking and procedures. Very entertaining reading, 'The Art of Science' covers all stages of scientific practice, from choosing a field of experimentation through record-keeping and on to presenting your results! Everything you need to plan a successful Science career is right here!

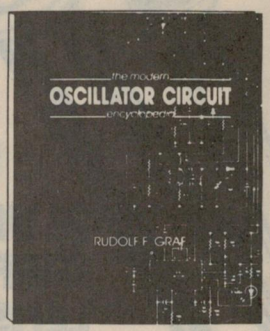
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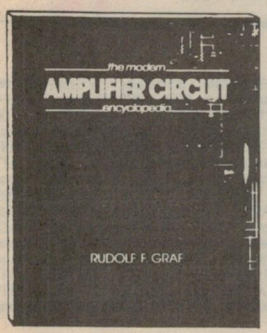
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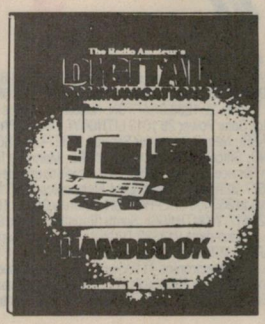


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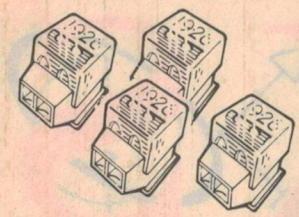
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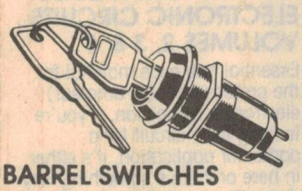


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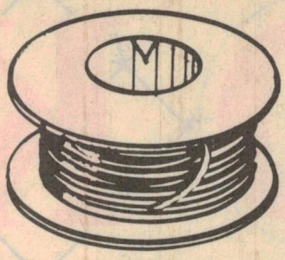
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For home or vehicle alarm installations, these switches keep control of the alarm in the hands of the rightful owner.

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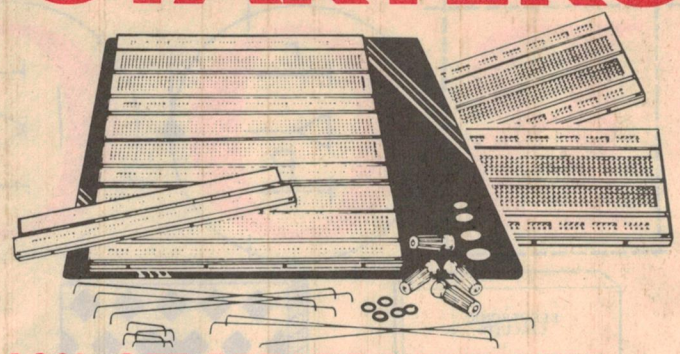
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500 Metre Roll



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Ideal for low voltage designs, breadboards are faster, easier and cleaner than working directly onto PCB's. All kits are mounted on a base-plate with non slip feet and holes for binding posts and come with jump wires and binding posts.

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As above, but without the base-plate, wires & posts.

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Forget about boring LED arrays forever! Now you can mix 'em up with our range of brilliant 5mm colour LEDs including the new blue LED with diffused white lens!



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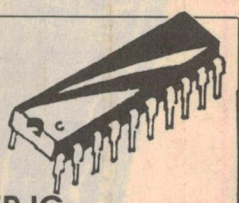
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BLUE DIFFUSED LENS

5mm Cat Z-4005

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NEW



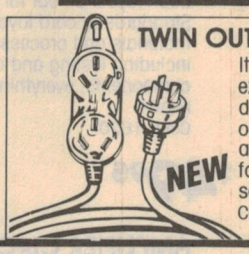
BARGRAPH AND V/U METER DRIVER IC

Drive your bargraph further! This new bargraph/array driver IC with peak hold is the same as you'd find in most quality commercial stereos. Exclusive to Dick Smith Electronics, it leaves an indicator lit to indicate the most recent peak point.

Cat Z-6291

Check For Availability

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NEW

TWIN OUTLET EXTENSION LEAD

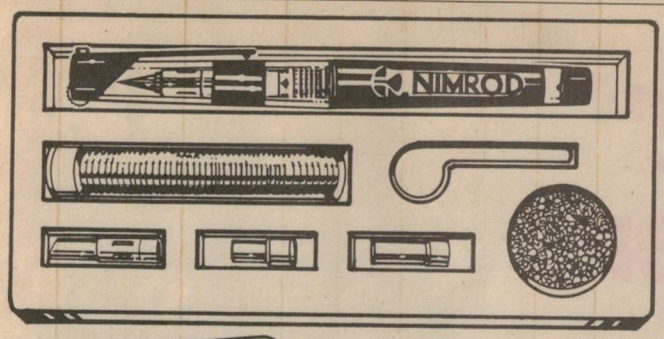
It takes two! A 1.8m extension lead with a heavy-duty moulded double adaptor on one end. The double adaptor has a hanger hole for added convenience. In safety yellow.

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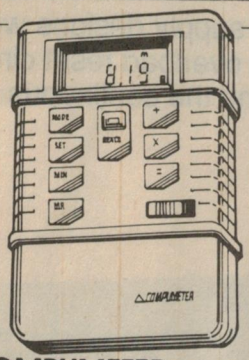


NIMROD SOLDERING KIT

This butane-powered, temperature-controlled (400-1300°C) soldering iron comes with many accessories: Includes stand, solder (with dispenser), tip cleaner, hot air tip, torch tip and hot knife tip. It's ideal for outdoor work (no power point required) and packs neatly into its own cushioned case.
Cat T-1395

$74.95 **NEW**

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COMPUMETER

Attention homebuyers, tradesmen, architects, estate agents or anyone else who needs to measure distances and prepare quotes: The Compumeter is an ultrasonic tape measure that measures distances from 55cm to 12.5m at the touch of a button! It displays both metric and imperial measurements on its LCD screen, adds, does area/volume calculations and has a memory function.
Cat Q-1407

$59.95

Requires 9V Battery



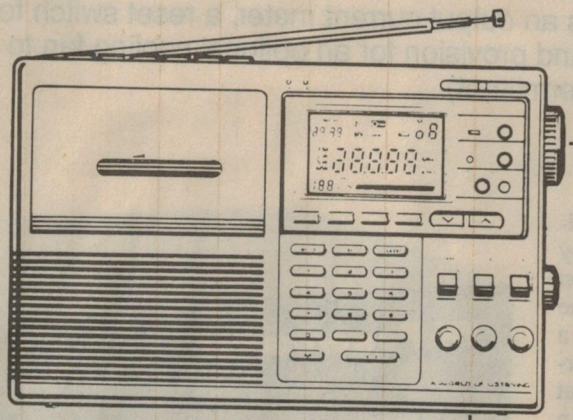
AC VOLTAGE FINDER

Now there's no need to put yourself at risk! This device detects the electromagnetic field surrounding cables, sensing any AC voltage above 120 volts and warns you with both an LED and an audible 'buzz'. At this low price, there's no excuse for not having one!
Cat Q-1531

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$16.95



With cassette player & timer!

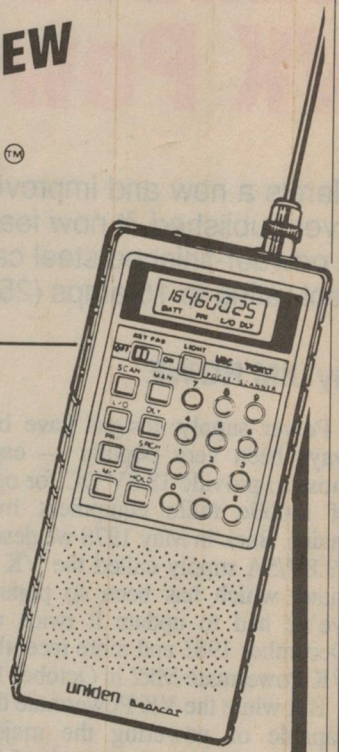
45 MEMORY ALL BAND RECEIVER

Open your ears to the world via shortwave. The Sangean ATS-818CS is an easy to use digital all-band world receiver, built to give you years of international listening pleasure. Covers local AM/FM bands, Longwave and continuous Shortwave frequencies from 1.62 to 30MHz. Features a built-in cassette deck, 45 memory channels and a large digital display which shows frequency, local/world times, memory channel selection and more! Also has a large direct-entry frequency keypad and standby recording function.
Cat D-2842

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A WORLD OF LISTENING



A Pocket-Sized, Powerful Performer!

70XLT SCANNING RECEIVER

Listen in to the radio-using community with this VHF/UHF hand-held scanner. It has 20 memory channels for storing your favourite frequencies, 8-band coverage (66-88, 136-174 & 406-512MHz) and track tuning for improved reception. Complete with an inbuilt rechargeable NiCad battery pack, AC charger, carry case and a two-year warranty! Exclusive to Dick Smith Electronics!
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STORES ACROSS AUSTRALIA AND NEW ZEALAND

Construction Project:

Enhanced 'Mk2' VK Powermaster

Here's a new and improved version of one of the most popular 13.8V power supply designs we've ever published. It now features an output current meter, a reset switch for the overload reset circuit, a powder-finished steel case and provision for an optional cooling fan to extend the continuous current rating to 15 amps (25A intermittent).

by JIM ROWE

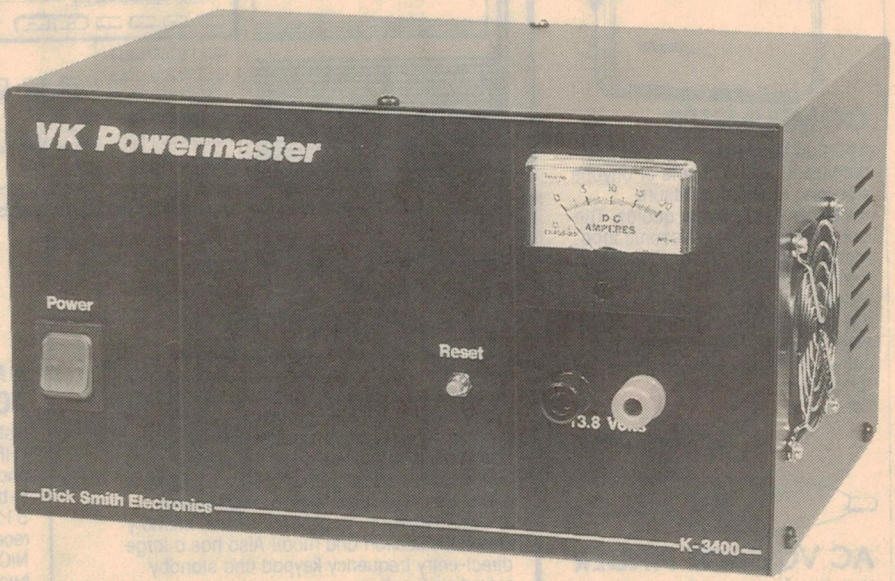
Power supply designs have been always been very popular — especially those to provide 13.8V DC for operation of mobile radio equipment from the mains. Back in May 1978 we described a 13.8V/5A supply called the VK Powermate, which has been so popular that we've had to update it twice now: in December 1983 and more recently as the VK Powermate Mk2 in October 1988.

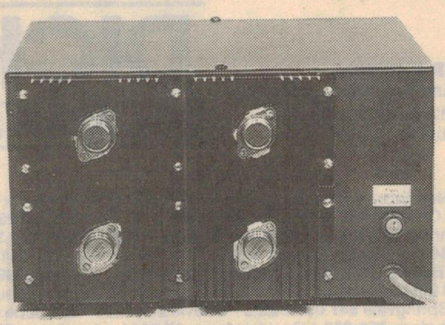
But while the VK Powermate design is capable of powering the majority of mobile radio transceivers, its 5A power rating has made it unsuitable for use with higher-powered equipment such as linear amplifiers. For these a somewhat 'huskier' supply is needed, and it was to fill this further need that we presented the design for a bigger brother of the Powermate, in the March 1984 issue: the VK Powermaster.

Designed by Rex Callaghan of the R&D Department at Dick Smith Electronics, the original VK Powermaster offered an excellent performance/cost ratio and has also been extremely popular. With a continuous current rating well over double that of the Powermate, and a peak current rating of 25A, it was capable of running all but the very highest-powered mobile gear. (And in January 1990 we described the VK Powermate 25, to cope with these too.)

But recently Rex Callaghan and his R&D colleagues at DSE decided that good though it was, the VK Powermaster design could still be improved. The original aluminium case was a bit light and spartan, for example, so they elected to replace it with a more professional powder-finished steel case, pre-punched and silk screened.

Over the years there had been quite a few requests for information on adding an output current meter, so they decided to add a built-in 0-20A meter. There had also been requests for a pushbutton to allow convenient resetting of the overcurrent protection circuit, so this was added as well.





Each of the four power transistors is mounted on its own finned heatsink. The correct mains fuse must be used.

Experiments had shown that the continuous current rating of the supply could also be increased to a comfortable 15A, if desired, by using a larger transformer and adding a cooling fan and a heatsink radiator for the rectifier bridge. So these were also provided for in the new design, along with some improvements to the basic design to enhance its transient overload tolerance and noise performance characteristics.

So that's the story behind this new, better than ever Mk2 version of the VK Powermaster design. Copyright for the front panel, case and PCB pattern for the new design is held by DSE, by the way, so in the form shown it can not be marketed by other firms. But DSE will be selling it as a basic kit, plus the

various options needed to build it in any of three forms — with performance ratings as shown in Table 1. The basic kit has the DSE catalog number K-3400, and is priced at $189.00 — not including the power transformer and bridge rectifier, or the optional additional heatsink, fan and filter components.

Circuit description

The circuit is very similar to that for the original VK Powermaster, which used a slightly unconventional approach in order to simplify the over-current protection system. The main rectifier section is quite standard, with an 18V secondary on the power transformer feeding a PB40 rectifier bridge followed by a parallel combination of four 10,000uF (10mF) reservoir capacitors. This provides the basic 'raw' DC output.

The regulator section uses discrete components, with a configuration which may seem 'upside down' because it has the series-pass transistors in the negative, rather than the positive rail. Although this is just as valid as the more usual arrangement, it may make it a little harder to follow its operation. The basic circuit is therefore shown in Fig.1, but with all of the polarities reversed so that you may find it easier to recognise.

As you can see, transistors Q2 and Q3 form a complementary- Darlington pair, acting as a series-pass emitter follower. Q1 acts as a comparator, comparing a preset fraction of the output voltage (applied to its base) with a regulated reference voltage at its emitter, established by the 220Ω resistor and 6.2V zener diode. In turn Q1 controls the base voltage and current of Q2, to provide a high degree of negative feedback and regulation of the output voltage, at a point where the voltage at Q1's base is just one Vbe drop (0.6V) above that at its emitter — i.e., at around 6.8V.

If the output voltage attempts to rise, the voltage at the base of Q1 will rise above this level; as a result Q1 will conduct more and this reduces the drive to Q2 and Q3, correcting the situation. Similarly if the output voltage tends to fall, the voltage at Q1's base will fall below 6.8V and Q1 will conduct less, increasing the drive to Q2 and Q3 to again correct the situation.

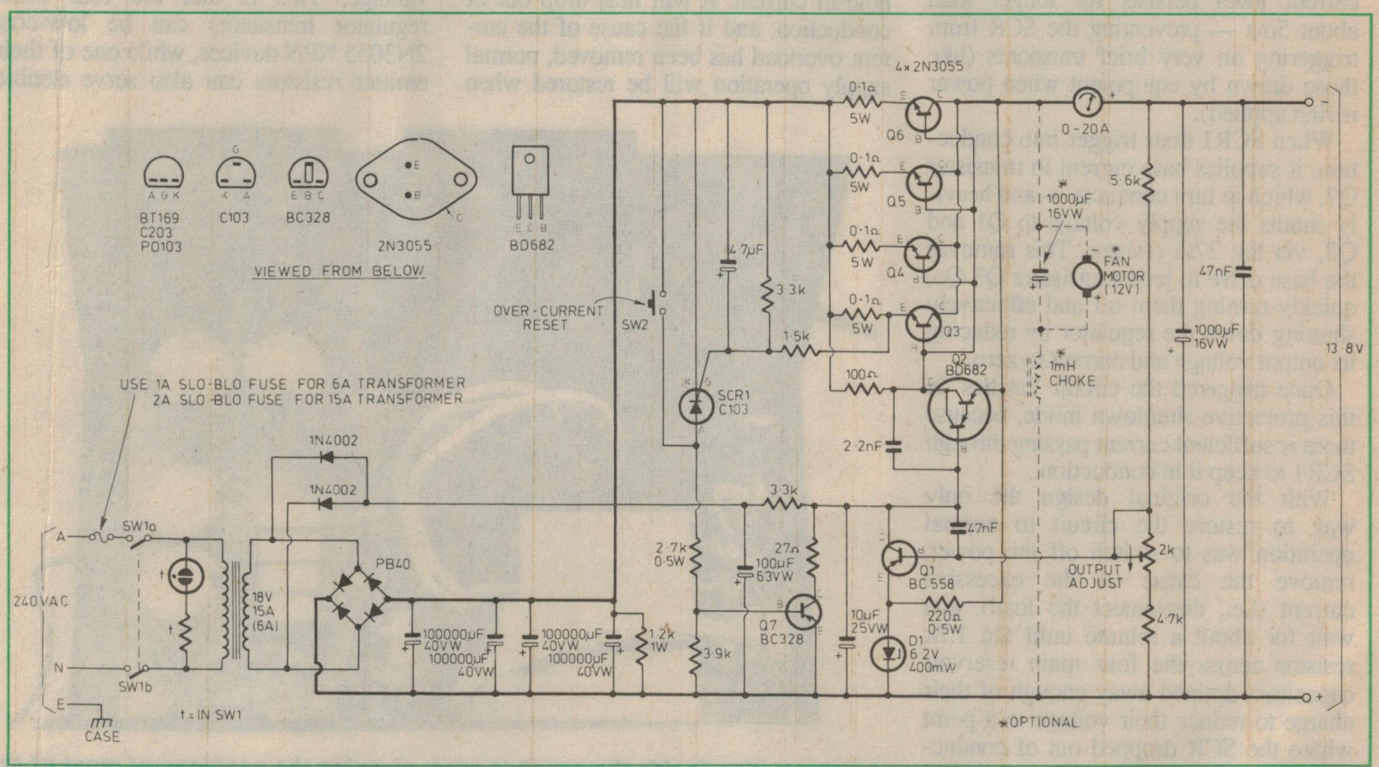
The preset pot in the base circuit of Q1 allows adjustment of the exact proportion of the output voltage fed back to the base, hence varying the output voltage level which corresponds to the circuit's stable operating point where Q1's base is at 6.8V. Another way of visualising the pot is as a control over the feedback loop's overall DC voltage gain. Either way, the bottom line is that the pot acts as an adjustment for the circuit's regulated DC output voltage, allowing it to be set to exactly 13.8V.

Note that with this kind of regulator configuration the supply current for Q1 and the base of Q2 is best fed from a separately derived and filtered voltage source, to ensure optimum regulation at high currents. As we'll see in a moment, this also allows use of a relatively simple circuit for over-current protection.

Hopefully with this understanding of basic circuit operation based on Fig.1, you'll now be able to make sense of the full schematic — despite the reversed polarities. Comparator transistor Q1 is now a BC558 PNP transistor, with its emitter connected to a reference voltage of -6.2V provided by zener diode D1.

Transistor Q2 is now itself a BD682 PNP Darlington device, to provide sufficient current gain and output drive capability, while Q3 of Fig.1 has now become four 2N3055 NPN power transistors, connected in parallel and all mounted on finned heatsinks to provide the required high current rating. The four 0.1Ω/5W emitter resistors are used to ensure that they share the output current equally.

Note that the optional 0-20A ammeter, if used, is connected in the output line *before* the voltage divider feeding the base of Q1, so that it is 'inside' the regulator's feedback loop. This means that the meter's voltage drop is compensated by the regulator, and doesn't degrade the supply's regulation.



As you can see from the schematic, the Powermaster uses a fairly standard regulator configuration, except that it uses complementary devices to those often used — and hence may look 'upside down'.

The supply voltage for Q1 and the base of Q2 (now negative) is derived from the 18V transformer secondary using a pair of 1N4004 diodes, feeding a 100uF/63VW reservoir electro and a filter circuit using the 3.3k series resistor and 10uF/25VW electro.

Note also that both Q1 and Q2 have small capacitors connected between collector and base, to reduce their gain at high frequencies and hence reduce any likelihood of instability in the regulator's feedback loop.

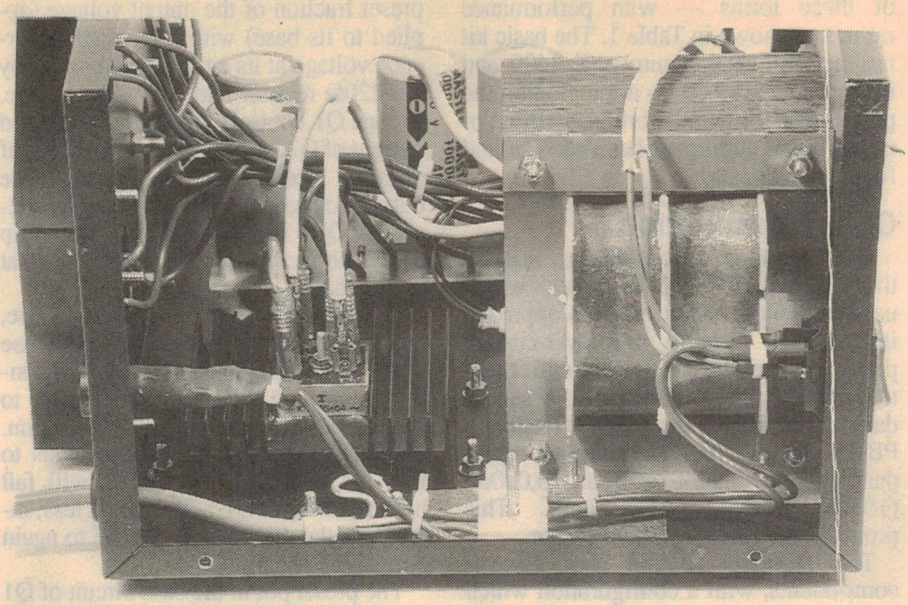
Now let's look at the circuit's over-current protection, based around SCR1 and Q7. The basic idea here is that SCR1 monitors the voltage drop across the emitter resistor of Q3; since this resistor carries 25% of the total load current, its voltage drop is thus directly proportional to load current (100mV for each 4A of total load current).

The gate-cathode circuit of SCR1 is effectively connected across this resistor, via the resistive divider formed by the 1.5k and 3.3k resistors. This means that when the total output current from the supply rises above about 27A, the gate-cathode voltage of SCR1 exceeds 0.65V and the SCR is triggered into conduction. The 4.7uF capacitor between gate and cathode is used to ensure that this only happens when the excessive load current level persists for longer than about 5ms — preventing the SCR from triggering on very brief transients (like those drawn by equipment when power is first applied).

When SCR1 does trigger into conduction, it supplies base current to transistor Q7, which in turn conducts — and heavily shunts the supply voltage to Q1 and Q2, via the 27Ω resistor. This removes the base drive to pass transistors Q3-Q6, quickly turning them off and effectively shutting down the regulator by reducing its output voltage and current to zero.

Once triggered the circuit 'latches' in this protective shutdown mode, because there is sufficient current passing through SCR1 to keep it in conduction.

With the original design the only way to restore the circuit to normal operation was to switch off the power, remove the cause of the excessive current (i.e., disconnect the load), and wait for about a minute until the 1.2k resistor across the four main reservoir capacitors drained away enough of their charge to reduce their voltage to a point where the SCR dropped out of conduction. Then the power could be switched back on, and the supply would return to normal operation.

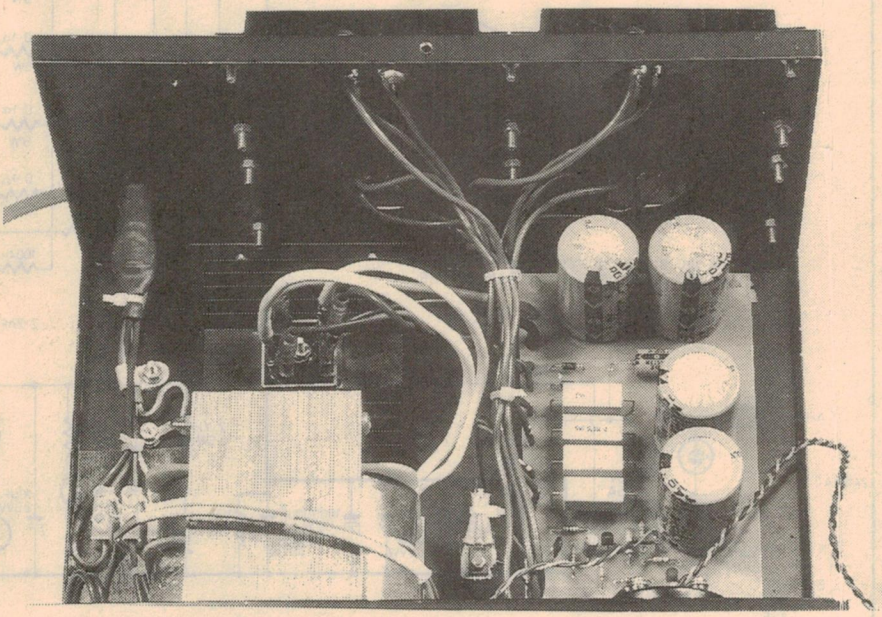


A view inside the left-hand end of the case, showing the mains wiring and also the rectifier bridge on its optional heatsink. As explained in the text, insulating sleeves should be fitted over all terminations of the mains wiring.

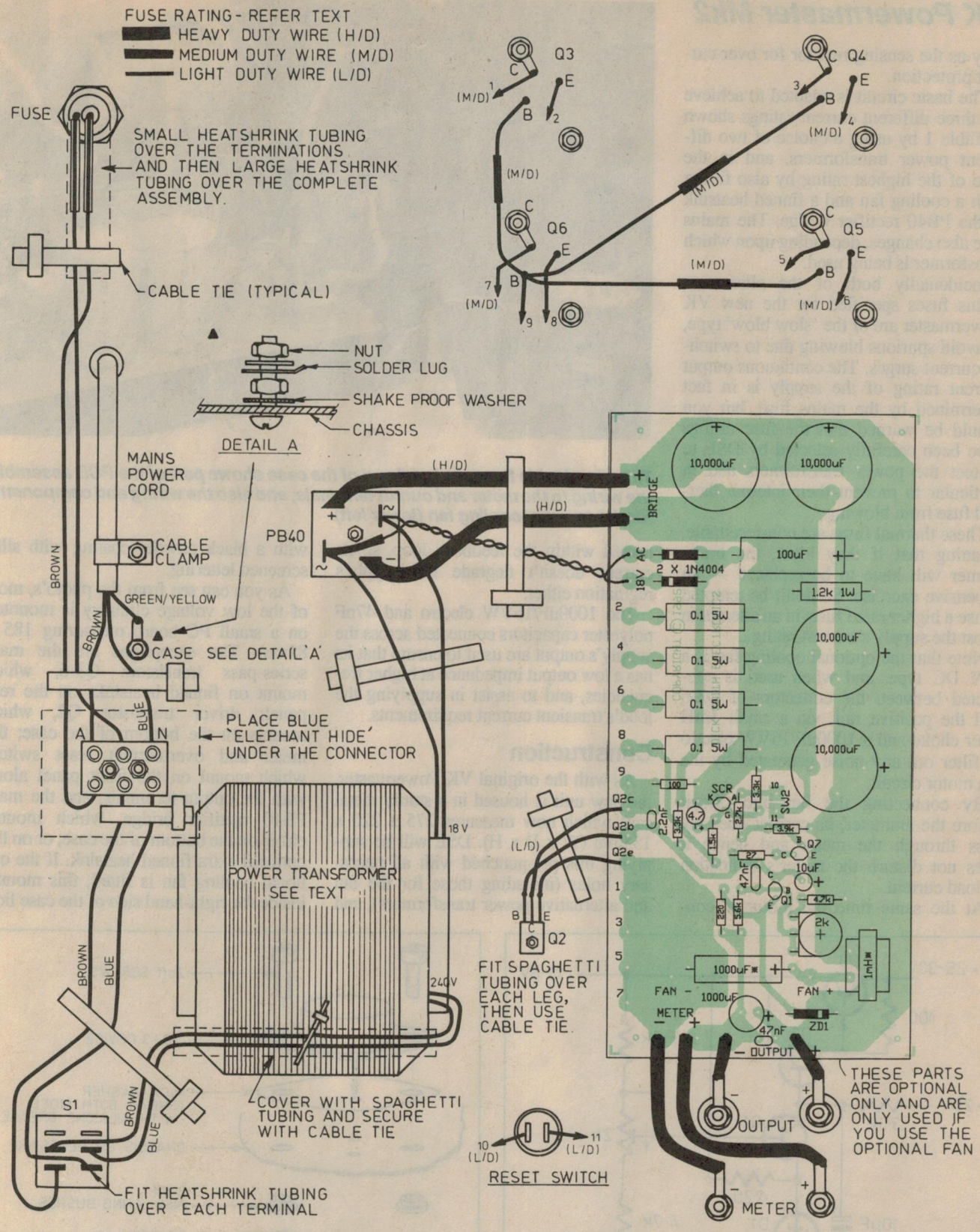
The addition of pushbutton SW2 to the design has made resetting more convenient. All you have to do now is disconnect the load (if the overload is due to a load fault), and press the button.

This places a temporary short between the SCR's anode and cathode, reducing its current to zero and hence removing its hold-in current. It will thus drop out of conduction, and if the cause of the current overload has been removed, normal supply operation will be restored when SW2 is released. Of course if the fault causing the overload is still present, the SCR will trigger on again and the circuit will latch off once more...

So that's the basic operation of the VK Powermaster circuit. Note that the final circuit configuration, 'upside down' compared with Fig.1, has one big advantage. This is that the four main regulator transistors can be low-cost 2N3055 NPN devices, while one of their emitter resistors can also serve double



A general view inside the supply's case, showing the positions of most of the major items. Note that the rectifier bridge is shown mounted on the optional finned heatsink (see text).



We've combined the usual PCB overlay diagram with a complete wiring diagram, to help you in assembling the new VK Powermaster. Note that the two components on the PCB marked with an asterisk are only required if the optional cooling fan is used to increase the supply's continuous current rating.

duty as the sensing resistor for over-current protection.

The basic circuit is adapted to achieve the three different current ratings shown in Table 1 by using a choice of two different power transformers, and in the case of the highest rating by also fitting both a cooling fan and a finned heatsink to the PB40 rectifier bridge. The mains fuse also changes, depending upon which transformer is being used.

Incidentally both of the alternative mains fuses specified for the new VK Powermaster are of the 'slow blow' type, to avoid spurious blowing due to switch-on current surges. The continuous output current rating of the supply is in fact determined by the mains fuse, but you should be warned that the fuse ratings have been carefully selected by DSE to protect the power transformers and in particular to prevent their internal thermal fuse from blowing.

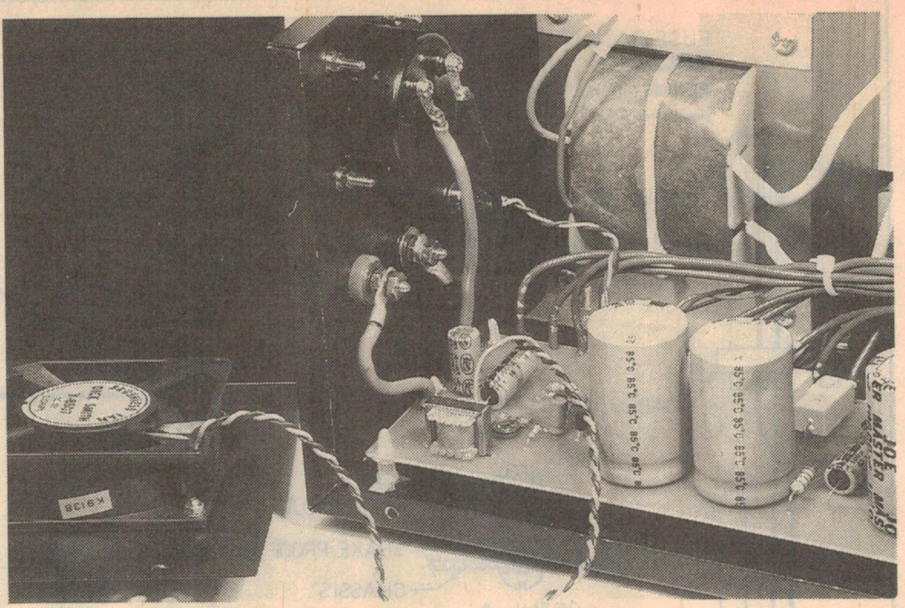
These thermal fuses are non-resettable, meaning that if they blow, the transformer will have to be replaced — an expensive exercise. So don't be tempted to use a higher rated fuse, in an attempt to boost the supply's current rating...

Note that the optional cooling fan is a 12V DC type, and when used is connected between the collectors of Q3-6 and the positive rail, via a small 1mH filter choke and a 1000uF/16VW electro to filter out any noise generated by the fan motor circuit.

By connecting the fan into circuit before the ammeter, its current does not pass through the meter and hence it does not disturb the meter's indication of load current.

At the same time the motor is connected within the feedback loop, so its current doesn't degrade the supply's regulation either.

The 1000uF/16VW electro and 47nF polyester capacitors connected across the supply's output are used to ensure that its has a low output impedance at higher frequencies, and to assist in supplying the load's transient current requirements.



This view inside the right-hand end of the case shows part of the PCB assembly, the wiring to the meter and output terminals, and also the wiring and components for the optional cooling fan (lower left).

Construction

As with the original VK Powermaster, the new unit is housed in a sturdy metal case which now measures 275 x 220 x 155mm (W x D x H). DSE will be supplying this pre-punched with all necessary holes (including those for the fan and alternative power transformers), and with a black powder coating with silk-screened lettering.

As you can see from the photo's, most of the low voltage circuitry is mounted on a small PC board measuring 185 x 88mm. The exceptions are the main series-pass transistors Q3-6, which mount on finned heatsinks on the rear panel; driver transistor Q2, which mounts on the bottom of the case; the meter and over-current reset switch, which mount on the front panel along with the output terminals; and the main PB40 rectifier bridge, which mounts either on the bottom of the case, or on the optional extra finned heatsink. If the optional cooling fan is fitted, this mounts inside the right-hand side of the case lid.

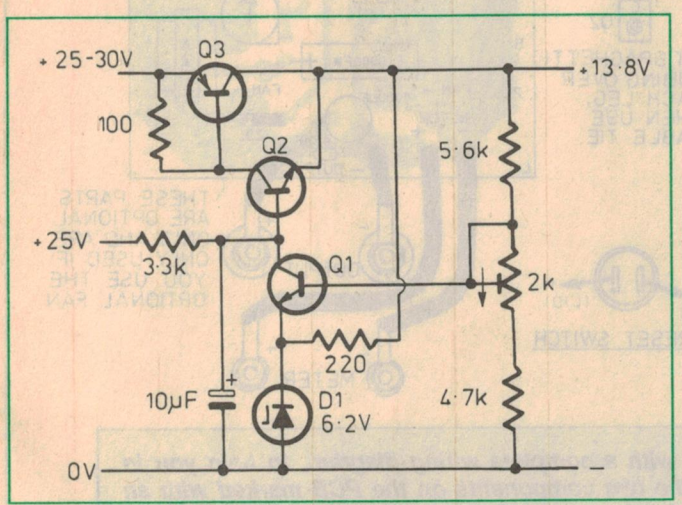


Fig.1: Here is the basic regulator configuration used in the Powermaster, drawn here using the more usual device polarities. The main circuit uses their complements.

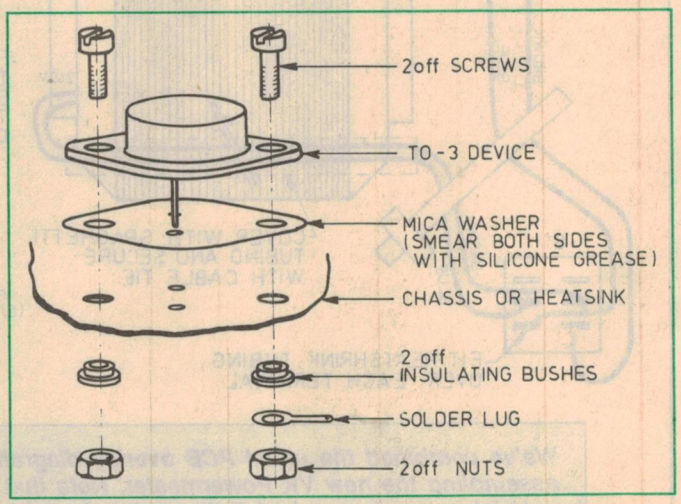


Fig.2: A detailed drawing showing the correct way of mounting the TO-3 power transistors. Ensure that the holes in the heatsink are carefully deburred first.

PARTS LIST

Resistors

(1/4W 5% unless indicated)
4 0.1 ohms 5W
1 27 ohms
1 100 ohms
1 220 ohms 0.5W
1 1.2k 1W
1 1.5k
1 2.7k 0.5W
2 3.3k
1 3.9k
1 4.7k
1 5.6k
1 2k linear trimpot

Capacitors

1 2.2nF metallised polyester
2 47nF ceramic
1 4.7uF 10VW electro (RB)
1 10uF 25VW electro (RB)
1 100uF 63VW electro (axial)
1 1000uF 16VW electro (RB)
4 10,000uF 40VW electro (RB)

Semiconductors

1 PB40 bridge rectifier
2 1N4004 silicon diodes
1 6.2V 400mW zener diode
1 BC558 PNP silicon transistor
1 BC328 PNP silicon transistor
1 BD682 PNP power Darlington
4 2N3055 NPN power transistor
1 C103 or similar SCR

Miscellaneous

1 Steel case, 275 x 220 x 155mm
1 PC board, 185 x 88mm (DSE ZA-1364)
4 Pre-drilled finned heatsinks
1 0-20A panel meter
1 Two-pole mains rocker switch, with inbuilt neon
1 Fuseholder, 3AG safety type
1 Three-wire mains cable with plug
1 Grille for cooling fan opening
1 Single pole momentary pushbutton(SW2)
Black and red screw terminals, heavy duty; 'Slo Blo' mains fuse (for rating see text); power transistor mounting hardware (4 x TO-3, 1 x TO-126); cable clamp; 10mm rubber grommet; 3-way mains terminal block; solder lugs; space lugs; PCB pins; fast-on connectors and 'double adaptor' lugs; nylon cable ties; 4 x rubber feet; 4 x nylon standoffs for PCB; silicone grease; light, heavy and very heavy hookup wire; heatshrink tubing and cambric 'spaghetti'; insulating paper; machine screws, nuts, flat and shakeproof washers; solder, etc.

Optional

1 12V 'muffin' cooling fan
1 1mH filter choke
1 1000uF 16VW electro (axial type)
1 Finned heatsink for bridge rectifier

Needless to say the power transformer mounts on the bottom of the case as well, while the mains switch SW1 mounts on the front panel at the left-hand end. The mains fuseholder is of the 'safety' type, and mounts on the rear panel just above the mains cable entry.

Wiring of the components on the PCB should be quite straightforward using the overlay/wiring diagram as a guide, but there are a few points to note. The four 0.1Ω 5W current sharing resistors should be mounted with their bodies about 5mm above the board, as they get quite hot when the supply is delivering higher current.

Another point to note is that although the 1mH filter choke and 1000uF 'axial' electro mount on the PCB, they are only fitted if you are adding the cooling fan option. Both are shown with asterisks on the wiring diagram, as a reminder.

Note too that there are a number of different SCRs that may be supplied with the kit, with two different pin orientations as shown on the schematic. The PCB overlay shows the correct orientation for the C103 type; it should be reversed for the other variety (BT169/C203/PO103).

A final point is that although the 2k preset pot used for output voltage adjustment is of the 'vertical mount' type, it is mounted here with its leads bent, so that it is nearly parallel with the PCB and only just above the surface. This is to permit easy adjustment when everything is assembled.

Once the PCB assembly is completed, it can be put aside while you mount the larger items to the case. Small diagrams are provided to show the recommended way to do this, including a diagram of the way the power transistors are fitted to their heatsinks. Note that all of the power transistors are electrically insulated from the heatsinks, while being thermally bonded to them via silicone grease and mica washers.

The same applies to driver transistor Q2, which is insulated via a TO-126 mica washer and insulating sleeve, while the underside of the bridge rectifier should also be smeared with silicone grease so it makes good thermal contact with the case.

Other small diagrams show the way that the mains cord should be clamped to the case, the mains connector block attached to it, the mains earthing solder lug fitted, and also how the DC output terminals are fitted. Further diagrams show how the optional fan is fitted inside the lid, and how the bridge rectifier is mounted on the optional extra heatsink.

Don't forget to carefully check all of the case and heatsink holes for metal burrs, before you mount anything. If you find any burrs these should be carefully removed with a small file or medium-sized twist drill; a burr on the mains cord entry hole could cut through the rubber grommet, while burrs on the various semiconductor mounting holes could prevent the correct insulation.

The main wiring diagram also shows how the various interconnecting wires inside the case should be sleeved and tied together, for maximum reliability and safety.

Note that the mains rocker switch SW1, which is fitted with an internal neon lamp, is simply snap-fitted into a matching rectangular hole in the front panel. Its connections are made using 'quick connect' push-on connectors, and these are also used for the connections to the bridge rectifier.

After mounting the main power transistors to their heatsinks, and Q2 to the bottom of the case, it would be a good idea to check their insulation from the case metalwork before you wire them to the PCB assembly. Then if there's an insulation problem, you'll be able to fix it before any damage can be done.

Again note that various types of insulated hookup wire should be used inside the supply, depending upon the current and/or voltage they're carrying. For example the mains wiring, between the connector block and the mains switch, and also to the fuseholder, should be in reasonably heavy wire with mains-rated insulation.

The usual colour coding should be observed, too: brown for active, blue for neutral and green/yellow for earth. After the various joints are made, according to the wiring diagram, they should each be covered with either tight fitting 'spaghetti' (varnished cambric) sleeving,

TABLE 1: Current Ratings[1]

	Basic with M-2000 transformer	Basic with M-2010 transformer	Upgraded[2] with M-2010 transformer
Continuous	5A	8A	15A[3]
Peak (1 min.)	10A	20A	20A
Surge (pulse)	25A	25A	25A

Notes:

1. Conditions are 240V AC input, 25 °C ambient temperature.
2. Upgrade consists of adding a DSE H-3470 heatsink to the bridge rectifier, a Y-8507 12V cooling fan to the case and a 1000uF 16VW electro and 1mH filter choke to the PCB.
3. The 15A limit is determined by the 2A primary circuit fuse. However this fuse rating must not be increased as it is designed to fail before the internal and non-resettable thermal fuse in the M-2010 transformer.

or small heat-shrink sleeving — threaded on before the joint is made. In the case of the fuseholder it is also good practice to cover the complete assembly with a sleeve of larger diameter heatshrink tubing, for added safety.

Similarly the leads from the PCB to the output terminals, ammeter and bridge rectifier should be in very heavy 'auto cable', with plenty of copper to handle currents of up to 25A.

Most of the rest of the wiring should be in medium-duty stranded hookup wire, such as 32 x 0.2mm, rated to carry currents of up to 10A. However the leads to driver transistor Q2, the reset pushbutton SW2 and the optional cooling fan can be run in light- duty hookup wire, such as that in 'rainbow' ribbon cable.

To prevent undue flexing and strain on the solder joints where the various leads are attached to the PCB assembly, it's suggested that you prepare all of the leads first and solder them to the PCB, before mounting it into the case. Then after fitting the completed PCB assembly in position you can simply connect all of the 'other ends' of the leads, without having to move the assembly any further.

The rear of the case has four large circular holes, to allow you to make the connections to the power transistors conveniently after they and their heatsinks are attached to the case. As shown in the photo's and indicated in the main wiring diagram, the completed wiring should be tidied up using nylon cable ties. This not only makes the interior a lot less cluttered, but also reduces the likelihood of wires 'wandering' and touching things they shouldn't, if any of your soldered joints should fail.

Testing & adjustment

When your VK Powermaster is complete, it's a good idea to check all of your wiring carefully before applying the power. Check it against both the wiring diagram and the schematic, if necessary, just to make sure — and be especially careful with the mains wiring.

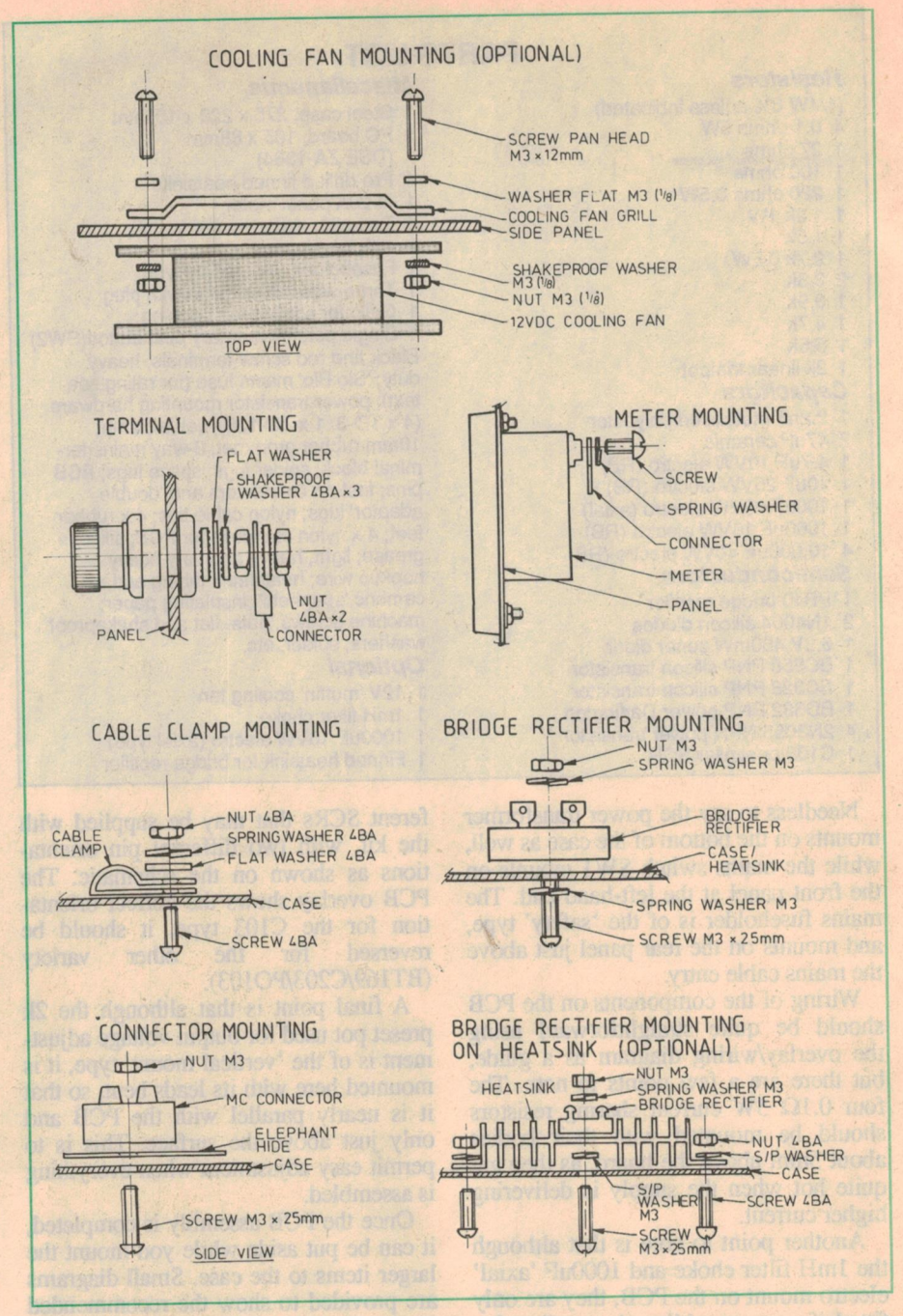
Then, if all seems well, make sure that the appropriate fuse has been fitted into the fuseholder, and you should be ready to apply the power.

Turning on the power should produce very little action, apart from a glow from the neon lamp in SW1 and possibly a slight hum from the power transformer. If you connect a DMM or multimeter across the DC output terminals, set to read DC voltage (say 0- 20V), you should get a reading somewhere between about 11.2V and 14V depending upon the exact voltage of your zener diode and the initial setting of your preset pot.

If the voltage is well outside this range, and particularly if anything is getting hot, switch off immediately and look for a wiring fault. Otherwise, you should be able to adjust the output voltage to exactly 13.8V using the preset pot.

That's really all there is to adjusting the supply, which should now be ready for service. If you wish, though, you can try testing the over-current protection circuit, by briefly applying a short circuit across the output terminals (using a short length of heavy-duty wire). The output voltage should immediately drop to zero, and the ammeter reading should merely give a brief upward flick before returning to zero. This state of affairs should remain even after the short is removed. However if you remove the short and then press the reset button SW2, the output voltage should re-appear as the supply swings back into life.

If your VK Powermaster comes through these tests with flying colours, you can be confident that it's working correctly. ❖



Use these further detailed drawings as a guide when mounting the optional cooling fan, the main output terminals, the ammeter, the mains connector block, and the bridge rectifier (both options).

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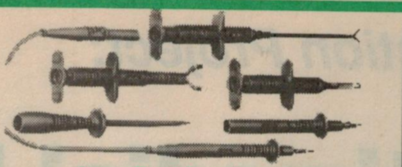
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HCK-7066-1/5M	0.75mm Silivolt 5m	$21.85
HCK-7066-2/5M	0.75mm Silivolt 5m	$21.85
HCK-7066-1/100M	0.75mm Silivolt 100m	$360.85
HCK-7066-2/100M	0.75mm Silivolt 100m	$360.85
HCK-7008-1/100M	1.00mm Flexivolt Cable	$121.00
HCK-7008-2/100M	1.00mm Flexivolt Cable	$121.00

2mm Test Leads

HCK-MS101	2mm Blk 1.0m Lead	$10.20
HCK-MS102	2mm Red 1.0m Lead	$10.20

2mm Test Fittings

HCK-8234-1	2mm Blk Hook Grip	$4.20
HCK-82342-2	2mm Red Hook Grip	$4.20
HCK-9217-1	2mm Blk Stackable Plug	$1.60
HCK-9217-2	2mm Red Stackable Plug	$1.60
HCK-9225-1	2mm Blk Test Prod	$3.25
HCK-9225-2	2mm Red Test Prod	$3.25
HCK-9229-1	2mm Blk Test Tweezers	$14.05
HCK-9229-2	2mm Red Test Tweezers	$14.05

4mm Test Leads

HCK-9014-1	4mm Blk Stght 1.0m Lead	$12.95
HCK-9014-2	4mm Red Stght 1.0m Lead	$12.95
HCK-9014-3	4mm Blu Stght 1.0m Lead	$12.95
HCK-9014-4	4mm Yel Stght 1.0m Lead	$12.95
HCK-9016-1	4mm Blk R/A 1.0m Lead	$13.80
HCK-9016-2	4mm Red R/A1.0m Lead	$13.80
HCK-9024-1	4mm Blk Stght 1.0m Lead	$14.20
HCK-9024-2	4mm Red Stght 1.0m Lead	$14.20
HCK-9026-1	4mm Blk R/A 1.0m Lead	$14.65
HCK-9026-2	4mm Red R/A 1.0m Lead	$14.65
HCK-9023-1	4mm Blk Sfty 1.0m Lead	$11.80
HCK-9023-2	4mm Red Sfty 1.0m Lead	$11.80
HCK-9025-1	4mm Blk Sfty R/A 1.0m	$12.25
HCK-9025-2	4mm Red Sfty R/A 1.0m	$12.25
HCK-S051	4mmBlk16A 0.5M Lead	$9.80
HCK-S052	4mm Red 16A 0.5M Lead	$9.55
HCK-S053	4mm Blu 16A 0.5M Lead	$9.80
HCK-S054	4mmYel 16A 0.5M Lead	$9.80
HCK-S055	4mm Grn 16A 0.5M Lead	$9.80
HCK-S056	4mm Vio 16A 0.5M Lead	$9.80
HCK-S101	4mm Blk 16A 1.0m Lead	$10.60

4mm Test Leads (cont)

HCK-S102	4mm Red 16A 1.01U Lead	$11.80
HCK-S103	4mm Blu 16A 1 .0U Lead	$11.80
HCK-S104	4mm Yel 16A 1.0m Lead	$11.80
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HCK-9123-1	4mm Blk Coupling XHK	$2.20
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HCK-9295-1	4mm Blk Crocodile 34A	$5.05
HCK-9295-2	4mm Red Crocodile 34A	$5.05
HCK-9209-1	4mm Blk Crocodile 2A	$2.80
HCK-9209-2	4mm Red Crocodile 2A	$2.80
HCK-9206-1	4mm Blk Hexagonal Probe	$3.60
HCK-9206-2	4mm Red Hexagonal Probe	$3.60
HCK-9112-1	4mm High Voltage Prod	$4.95
HCK-9112-2	4mm Red High Volt Prod	$4.95
HCK-9113-1	4mm Blk High Volt Prod	$5.55
HCK-9113-2	4mm Red High Volt Prod	$5.55
HCK-9116-1	4mm Blk Hook Grip	$12.85
HCK-9116-2	4mm Red Hook Grip	$12.85
HCK-9119-1	4mm Blk Jaw Grip	$19.95
HCK-9119-2	4mm Red Jaw Grip	$19.95
HCK-9124-1	4mm Blk Adaptor XSA	$4.45
HCK-9124-2	4mm Red Adaptor XSA	$4.45
HCK-9214-1	4mm Blk Panel Mount Socket	$4.35
HCK-9214-2	4mm Red Panel Mount Socket	$4.35
HCK-9132-1	4mm Blk Panel Twin Socket	$4.70
HCK-9132-2	4mm Red Panel Twin Socket	$4.70
HCK-9205-1	4mm Blk Square Probe	$3.20
HCK-9205-2	4mm Red SquareProbe	$3.20
HCK-9203-1	4mm Blk Stackable Phg	$3.25
HCK-9203-2	4mm Red Stackable Plug	$3.25
HCK-9230-1	4mm Blk Test Tweezers	$13.70
HCK-9230-2	4mm Red Test Tweezers	$13.70

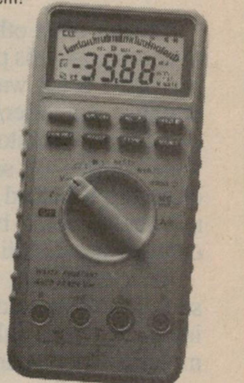
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Construction Project:

'Multimedia' Mini Amplifier

Here's a simple low-cost project that is so useful, you may well wonder how you've managed without it. It's a small high-quality speaker system with a versatile amplifier built into the base, allowing it to monitor almost any audio signal while delivering surprisingly good sound. Just the shot for improving the sound from your computer, or personal CD/tape player!

by ROB EVANS

As with most other truly useful pieces of equipment, this project was born out of necessity. What was needed was a small portable amplifier/speaker system that could easily monitor audio signals from a wide variety of sources, yet offered a clear and balanced sound so that the signal quality could be assessed, or simply enjoyed at near-hifi quality.

As it turns out, the range of uses for such a unit is much wider than we had imagined. Not only can it be used to monitor the sound from workbench projects, radio and video equipment, small personal CD and tape players; it's also ideal for boosting the signals from computer sound cards and CD-ROM players — hence the 'Multimedia Mini-Amp' tag.

The final project has more than met our original goals. It offers an amplifier which delivers around two watts with a distortion of less than 0.3% at the onset of clipping, and a speaker response which is quite flat over the range 80Hz to 10kHz. While these figures may not seem all that impressive in absolute hifi terms, rest assured that in practice the mini-amp delivers a surprisingly loud and clean sound for such a small unit.

In fact, the performance is such that two units could well be used as the basis for a very effective mini hifi system — all you need to add is a signal source and a couple of hookup cables. Since the mini-amp uses common low cost parts, the final system would be quite inexpensive.

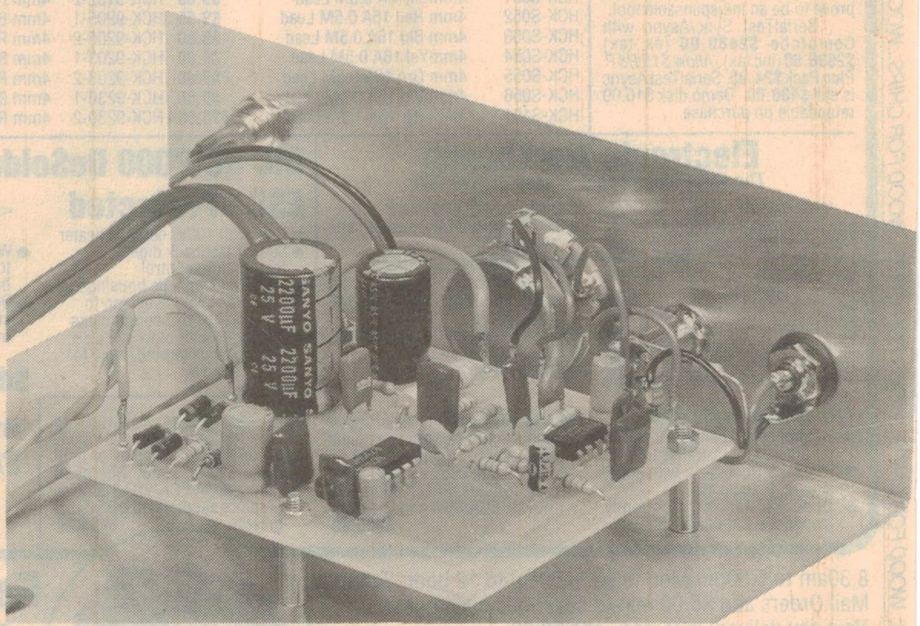
The mini-amp's speaker system is based around a low-cost ($12.95) twin-cone driver available from Jaycar Electronics (Cat. No: AS- 3011), which was designed for car sound applications. It has a generous magnet structure, a nominal diameter of 125mm, and comes equipped with its own protective grill. As a further indication of its car sound heritage, the driver has a rated impedance of four ohms and carries the well-known Clarion brand name.

After some testing, the driver was found to have a free-air resonance of 128Hz, a Vas figure of around 3 litres, and a total Q (Qts) of about 0.7. When installed in a 6-litre vented cabinet tuned to about 97Hz, this gave us reasonably smooth response down to about 80Hz and a very steep roll-off of about 35dB/octave below this point. (The same sized sealed enclosure would produce a response that begins to roll-off from about 200Hz, by the way.)

On the amplifier side of things, we found that the ubiquitous LM380 power amp IC couldn't really be bettered for our application. It's low in cost and readily available, uses very few external components, and has both short-circuit and thermal limiting capabilities — and of course, delivers quite acceptable noise and distortion performance. Since we had chosen a readily available and low-cost '2851' type transformer as the basis of the power supply, its 1.8VA rating limited our maximum audio output power to about 2 watts — quite within the capabilities of the LM380.

In practice however, we found that the LM380 could deliver a rather higher short-term power into our 4 ohm speaker load, since while the power supply is only capable of delivering a low *continuous* current (thanks to the modest rating of the 2851 transformer), its instantaneous current ability is mainly set by the size of the supply's filter capacitor. Needless to say, we fitted a generously-rated main filter capacitor.

The end result is that while the amp is rated at only 2 watts (continuous effective), it is able to produce a somewhat higher output for music signals. When



The amplifier PCB mounts just behind the unit's front panel controls, on three small standoffs. A rubber grommet is used to insulate the RCA socket from the chassis.



this is coupled to an efficient loudspeaker system, such as our car speaker in its vented box, there is more than enough acoustic output for any reasonable application.

During the development of this project however, we found that the efficient nature of the speaker had a rather unfortunate side effect. While the bass response was pleasantly extended (thanks to the vented enclosure), both subjective and objective tests indicated that the speaker exhibited a broad peak (around 10dB) in its response around the 1kHz region.

Since this produced a somewhat harsh sound and therefore didn't really fit into our design aims, we elected to include a corrective response curve into the amplifier itself.

As you would expect, the resulting equalisation curve has a 10dB dip in the same area where the speaker peaks. While some readers may consider this to be taking a 'band-aid' approach or even cheating, we can testify that the solution works extremely well in practice.

As you can see from the shots of the final design, the amplifier features a very simple front panel layout, with an RCA input connector, an input attenuator switch so the unit can cope with a wide range of signal levels, a volume control, and a power indicator LED.

While the amplifier has a tailored frequency response to suit the small speaker used in the project, its versatile nature means that it could also be used for a host of other applications — it's quite a simple operation to change or even bypass the equalisation. For that matter, there's no reason why the enclosure/ driver combination couldn't be put to use in other applications, provided some alternative form of equalisation is available.

Circuit description

The amplifier's circuit is quite straightforward, and uses just two ICs and a handful of other components. As shown in the schematic diagram, signals are first applied to the buffer/ equaliser stage based around a TL071 opamp (IC1), then passed via the volume control (RV1) to the LM380 power-amp chip (IC2).

Following the signal path through, you can see that the input socket is directly connected to an attenuator based around R1 and R2, which reduces the signal passed to IC1 by 20dB, when SW1 (level) is in the 'low' position. Conversely, with SW1 in the 'high' position, signals are passed at full strength.

The output of SW1 is then coupled to the non-inverting input (pin 3) of IC1 via coupling capacitor C1, where a bias level of about 4.5V (Vref) is applied by resistor R3. The combination of C1 and R3 also serves as a high-pass filter, attenuating unwanted signals below about 30Hz.

IC1 is arranged as a standard non-inverting amplifier, but with an increased gain at high frequencies as set by the feedback components R5 and C2. These progressively decrease the level of negative feedback for frequencies above about 700Hz (at a rate of 6dB per octave), until the gain is finally set by the combination of R6 and R5 for signals above about 8kHz.

The resulting output at pin 6 of IC1 has a gain of two (+6dB) at lower frequencies as set by R4 and R6, and moves to a gain of 14 (23dB) at high frequencies, as determined by the combination of R5 and R6 mentioned above. Note also that frequencies above the audio band are restricted by the feedback action of C3 in conjunction with R6. The frequency response of this first stage is shown as the top trace in Fig.1.

This treated signal is then passed to the volume control RV1 via coupling capacitor C5, and on to a *second* filter composed of R7, R8 and C6. In this case however, the components form a passive low-pass filter, and roll off the higher frequencies above about 100Hz at the same 6dB/octave rate. The effect then continues up to about 1kHz, where the attenuation levels off at -21dB, as shown by the lowest curve in Fig.1.

The combined effect of these cascaded filters results in the response which appears as the middle curve of Fig.1, between the two filter plots.

Note how the mid-range frequencies are reduced by about 10dB, and the extremes of the band are rolled-off due to the effect of C1 at the low end, and both C3 and C7 at high frequencies. This equalised signal is then applied directly to the LM380 power amp IC (at pin 6), which has a fixed gain of 50 (34dB).

The LM380 is arranged in an inverting mode, with the non-inverting input (pin 2) bypassed by C8, and its internal bias supply bypassed by C9 at pin 1. Pins 3, 4, 5, 7, 10, 11, and 12 are all at ground potential, and serve as a heat dissipation path for the IC's internal chip.

The final output at pin 8 is

bypassed by a Zobel network consisting of R9 and C11 — which applies a fixed load at high frequencies to maintain the amp's stability — and is coupled to the speaker load by the 1000uF capacitor C12.

Other stability components around the circuit include the supply bypassing capacitors C4 and C10 on IC1 and IC2, respectively.

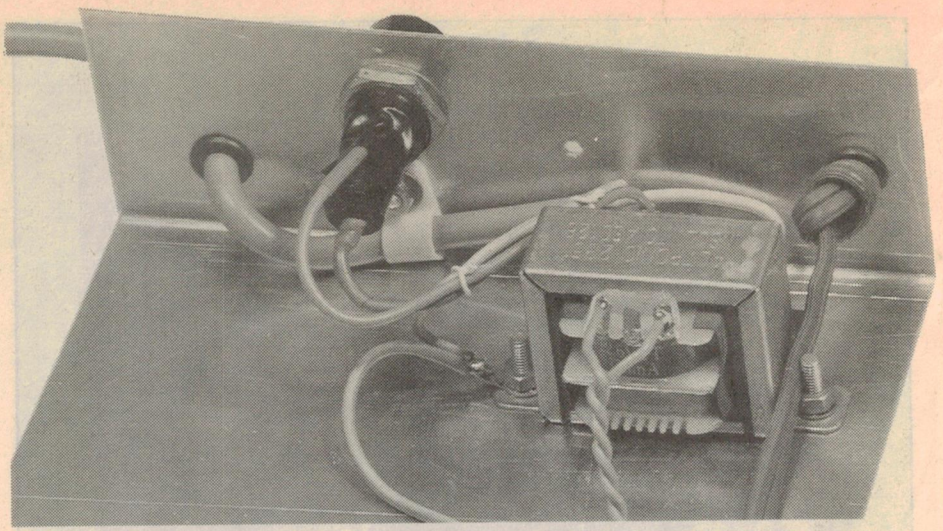
The remaining section of the schematic shows the amplifier's power supply, which is based on a low cost 2851-type transformer feeding a standard full wave rectifier circuit formed by diodes D1 to D4 and filter capacitor C13. The resulting voltage is applied to IC2 (at pin 14), the power indicator LED1 and its limiting resistor R14, and the voltage stabilising components R10 and zener diode ZD1.

R10 and ZD1 produce a fixed supply of about 9V, which is filtered by C14 and applied both to IC1 (at pin 7), and the bias supply components R11, R12 and C15. This circuit generates a stable reference voltage of about 4.5V (Vref), which is used to set the operating point of IC1 via components R3 and R4. By the way, the lone 10 ohm 1W resistor tied between the input 'ground' connection and the chassis is used to hold the amp's circuitry at mains earth potential, while still providing some resistance in the path.

The idea here is avoid a *direct* connection, which would tend to promote hum-inducing ground loops between the amplifier and an earthed signal source.

Some constructors may wish to omit this resistor and leave the amplifier circuitry 'floating' for a more versatile monitoring ability, or simply install a link to positively earth the system — strictly speaking, this is the safest approach.

If the recommended 10-ohm 1W resistor is installed however, there is a low enough resistance between the circuitry and the mains earth to blow the 250mA fuse in the transformer's primary circuit, in the unlikely event of a primary to secondary breakdown.



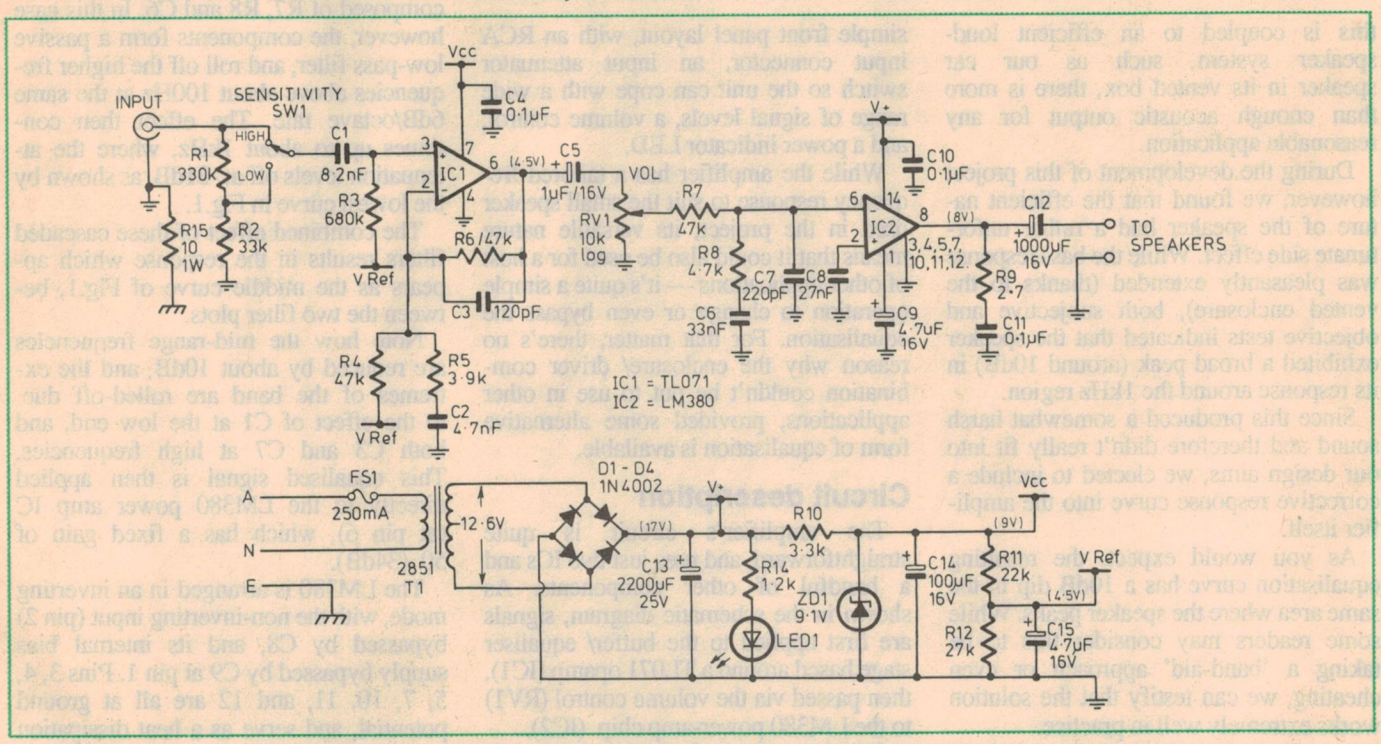
Make sure that the mains cable is quite secure, and all connections which are at mains potential are fully covered.

Amp construction

Our prototype amplifier is housed in a simple U-shaped section of aluminium plate, which was cut from a standard 300mm x 300mm sheet as sold by a number of component suppliers.

Since the opening in the speaker cabinet has a width of 150mm, this allows two such sections of plate (each measuring 300mm x 150mm) to be cut from the one standard sheet, which is convenient for those who wish to build a *pair* of units for stereo monitoring.

Bend the two ends of the plate to a depth of about 50mm to produce the



The mini-amp's circuit is based around a TL071 op-amp acting as a buffer/equaliser stage, and an LM380 power amp IC which delivers around two watts into a four ohm load.

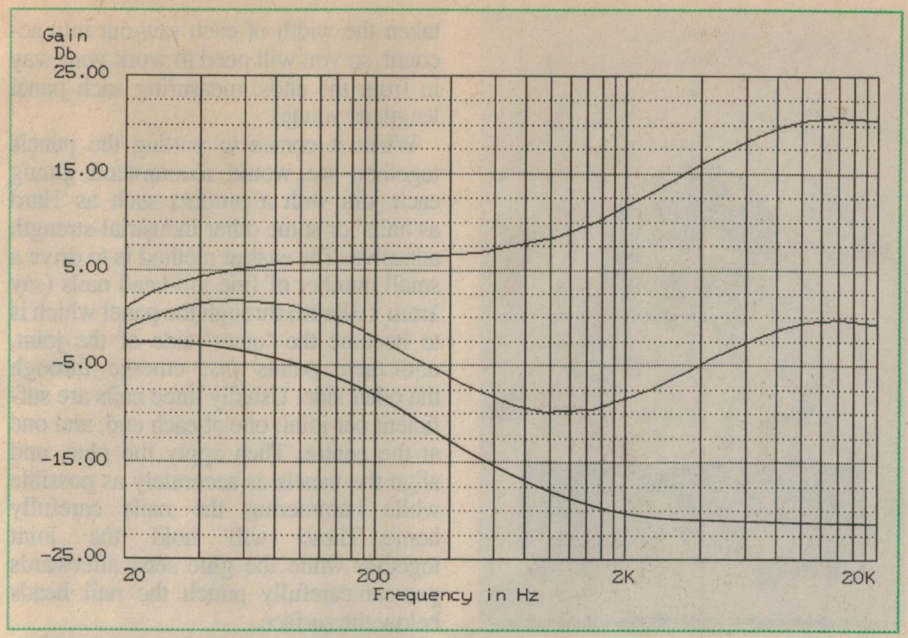


Fig.1: The upper curve shows the high-frequency boost applied by the amplifier's first stage, while the lower curve represents the cut applied to a following filter. The end result is the curve shown in the centre of the diagram, which is used to control the speaker's frequency response.

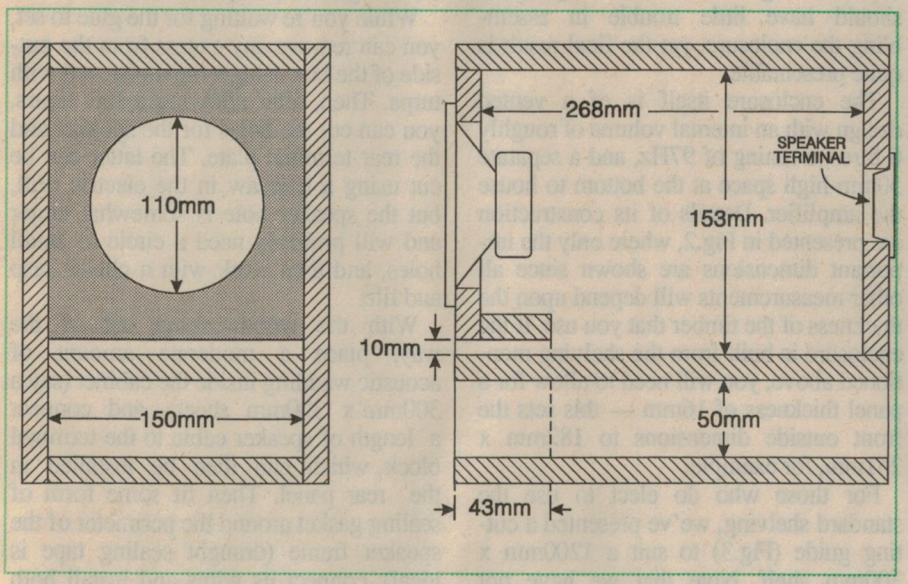


Fig.2: Use this construction guide when assembling the cabinet. Note that while the important dimensions are shown, the other measurements will depend upon the thickness of the timber.

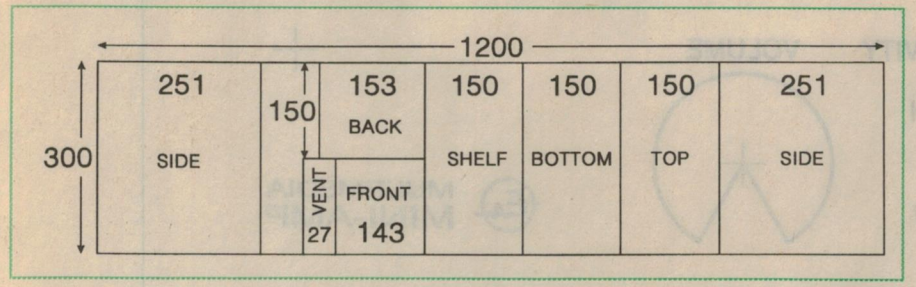


Fig.3: If you build the cabinet out of a standard laminated shelf as suggested in the text, follow this timber cutting guide. It assumes a timber thickness of 15mm, and doesn't allow for the timber lost with each saw-cut.

amplifier's front and rear panels, while making sure that the final chassis is a neat fit inside the speaker cabinet opening. The holes can then be drilled in the chassis to suit the various components and mounting bolts, and the front dress panel fitted (if available).

Note that the mounting bolts which are fitted to the bottom of the chassis will need to have *countersunk* heads and matching holes, so that the final amp will neatly slide into its opening in the speaker cabinet, without any protrusions to foul the bottom panel of the box.

Virtually all of the amplifier's components fit onto a small printed circuit board (PCB) measuring 79mm x 69mm, which is coded 92amp10 and has one relatively large section of copper pattern to act as a heatsink for the LM380 power amp IC.

The components should be fitted to the circuit board in the usual progressive manner, working your way from the low profile parts (resistors, etc) through to the larger items.

Use the supplied component overlay diagram during construction, and take particular note of the orientation of any polarised components — these include all of the semiconductors and the electrolytic capacitors. Also note that IC1 and IC2 are not installed with the same orientation, and pin 1 faces towards the perimeter of the PCB in both cases.

Once the PCB has been assembled to your satisfaction, the board can be mounted into the bottom of the chassis on small standoffs. The best position is close to the front panel and adjacent to the volume control and input socket/switch, as shown in the photographs of the prototype unit.

Next, all of the remaining parts can be installed in the chassis, and the interwiring completed as shown in the component overlay diagram. Note that R2 is mounted between the input socket's ground lug and SW1, while R1 is connected directly between the outer terminals of SW1.

Also note that the RCA input socket should be the type fitted with a plastic insulating bush — or alternatively, a standard socket which is mounted into the panel via a small rubber grommet, as in our prototype.

Take particular care when it comes to the mains wiring, since your life may depend upon the thoroughness of your work. The transformer should be securely attached to the chassis with nuts, bolts and lock washers, and a solder lug included on one side for the main earth connection. The mains lead should pass through the rear panel via a protective rubber grommet, and be

secured by a plastic P-clamp as shown in the prototype.

The earth lead (green/yellow) from the mains cable is soldered directly to the earth lug, the neutral wire (blue) goes straight to one side of the transformer primary, while the active lead (brown) is connected to the pin which is at the tip (or end) of the fuse holder. The holder's other pin (its 'output') should then be wired to the remaining side of the transformer primary. Note that any connections which are, or could be at mains potential (both the active *and* neutral wiring) should be thoroughly insulated using heat- shrink tubing, and insulation tape where necessary.

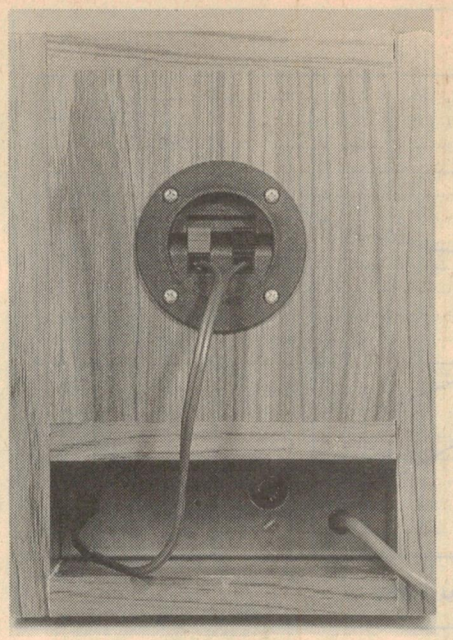
If the transformer at hand has flying lead connections rather than lugs, you will need to fit a small section of mains-rated terminal strip between the mains cable and the primary leads. This should be securely bolted to the amp's chassis, and again, any exposed mains wiring covered by some form of insulation.

Box construction

In the interests of simplicity, our prototype enclosure was built from a standard (1200mm x 300mm) length of particle board shelving, which comes with a convenient laminate finish. This modular shelving is available in a number of colours (white, beige, grey, and 'woodgrain'), is quite reasonably priced, and can be found at most of the larger hardware stores — it's an off-the-shelf item, so to speak...

After a little calculation, it was clear that if the required panels were cut from the shelf in a specific order, the 'finished' edge of the timber could be used on all visible sides of the box, whilst still using simple butt joins during its construction.

This is of considerable advantage, since a constructor with a minimum of both woodworking tools and experience should have little trouble in assembling the enclosure, yet the final result is quite presentable.



A rear shot of the unit. Note how far the amplifier sits into the cabinet opening.

The enclosure itself is of a vented design with an internal volume of roughly 6 litres, a tuning of 97Hz, and a separate 50mm-high space at the bottom to house the amplifier. Details of its construction are presented in Fig.2, where only the important dimensions are shown since all other measurements will depend upon the thickness of the timber that you use. If the enclosure is built from the shelving mentioned above, you will need to allow for a panel thickness of 16mm — this sets the front outside dimensions to 182mm x 251mm, for example.

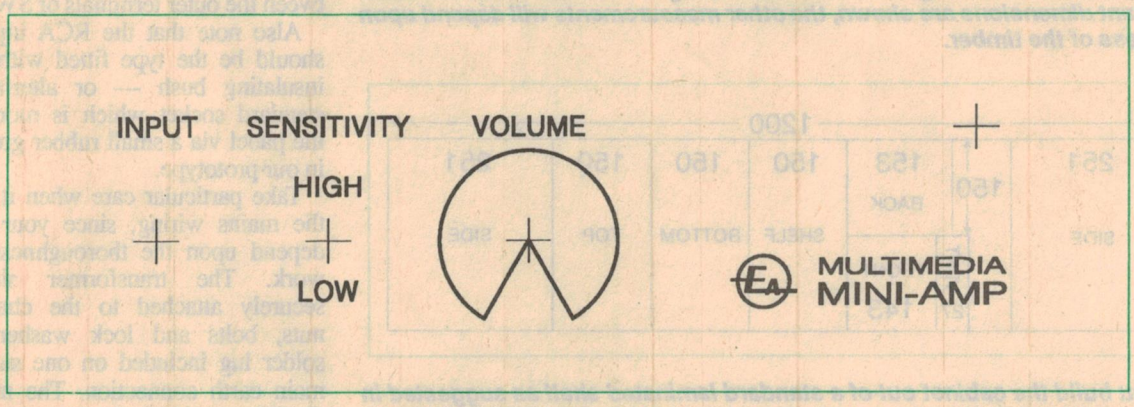
For those who do elect to use the standard shelving, we've presented a cutting guide (Fig.3) to suit a 1200mm x 300mm shelf. Note that we have not taken the width of each saw-cut into account, so you will need to work your way in from the ends, measuring each panel length as you go.

When it comes to putting the panels together, we would recommend gluing each join with a product such as 'Hard as nails' or some other industrial-strength adhesive. The easiest method is to drive a small number of fine jolt-head nails (say 1mm x 38mm) through the panel which is to become the 'outer' side of the joint, until their points *just* emerge through the other side. Usually three nails are sufficient per joint: one at each end, and one at the centre. Then apply the glue, and align the panels as accurately as possible while hammering the nails carefully home. These will hold the joint together while the glue sets; afterwards you can carefully punch the nail heads below the surface.

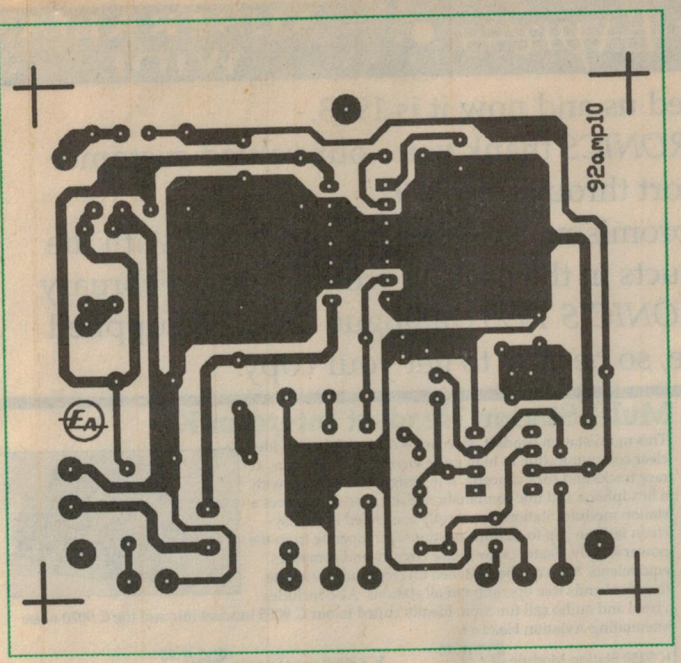
By the way, the common 'white' PVA woodworking glue is quite unsuitable for the job, since it won't bond to the smooth laminate finish, and just tends to soak into the end grain of the particle board.

While you're waiting for the glue to set, you can remove any excess from the outside of the box using a rag moistened with turps. Then, after allowing a few hours, you can cut the holes for the speaker and the rear terminal plate. The latter can be cut using a holesaw in the electric drill, but the speaker hole is somewhat larger and will probably need a circle of small holes, and then work with a chisel, rasp and file.

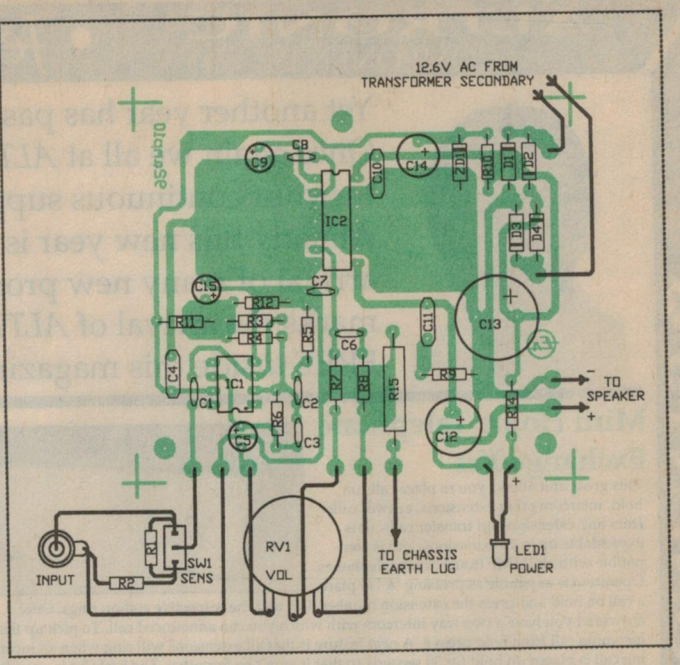
With the woodworking out of the way, place a moderate amount of acoustic wadding inside the cabinet (say a 300mm x 300mm sheet), and connect a length of speaker cable to the terminal block, which can then be installed in the rear panel. Then fit some form of sealing gasket around the perimeter of the speaker frame (draught sealing tape is ideal), connect its wires and install both



The front panel artwork, shown here actual size.



A full sized copy of the PCB artwork for the amplifier for those who wish to make their own.



Follow this component overlay diagram at all times during construction.

the driver and its protective dress cover in the cabinet.

Powering up

At this stage you're ready to give the system a trial run, just to make sure everything is working as it should. Before fitting the amplifier into its housing at the bottom of the speaker box, connect its output lead to the speaker and apply power. You should hear a small 'plop' from the speaker as the amp comes to life, then a very slight amount of hiss, depending upon how far the volume control is advanced.

Next, connect a signal source to the amp's input, wind up the wick, and check the audible results. If all is well, you should be pleasantly surprised by the quality of the overall sound, and find that quite a reasonable volume level is available before the amp begins to run out of steam.

If there appears to be a problem with the amplifier, immediately turn the power off, and double check your wiring. The circuit diagram includes the voltage levels at the important points around the circuit, and these can be checked against those in your unit, as a guide to faultfinding.

Finally, the amplifier can be installed in its rightful home and a couple of self-tapping screws used to lock it in position. These can be installed through the bottom of the cabinet into the amplifier chassis, and positioned so that they protrude through the aluminium at a safe distance from any of the amp's parts.

PARTS LIST

Resistors

(All 0.25W 5% unless noted):
1 x 680k, 1 x 330k, 3 x 47k, 1 x 33k, 2 x 27k, 1 x 4.7k, 1 x 3.9k, 1 x 3.3k, 1 x 1.2k, 1 x 10 ohms 1W, 1 x 2.7 ohms
1 10k logarithmic potentiometer

Capacitors

1 2200uF 25V PC-mount electrolytic
1 1000uF 16V PC-mount electrolytic
1 100uF 16V PC-mount electrolytic
3 4.7uF 16V PC-mount electrolytics
3 0.1uF metallised polyester
1 33nF metallised polyester
1 27nF metallised polyester
1 8.2nF metallised polyester
1 4.7nF metallised polyester
1 220pF ceramic
1 120pF ceramic

Semiconductors

1 LM380 14-pin power amp IC
1 TL071 opamp
4 1N4002 power diodes
1 9.1V 1W zener diode
1 LED in panel-mount bezel

Miscellaneous

1 125mm twin-cone speaker (Jaycar Cat. No. AS-3011 or similar)
1 Laminated pineboard shelf, 1200mm x 300mm x 16mm
1 PCB 69mm x 79mm, coded 92amp10
1 2851 power transformer, 12.6V at 150mA
1 Aluminium sheet, 300mm x 150mm
1 2-pole spring loaded speaker terminal
1 Insulated RCA socket (see text)
1 SPDT miniature toggle switch
1 3AG panel-mount fuse holder
1 3AG 250mA fuse
1 Mains lead with moulded plug
1 Plastic knob
Nuts and bolts, lock washers, rubber grommets, solder lug, hookup wire, speaker wire, plastic P-clamp, PCB spacers, heatshrink tubing, acoustic wadding (Innerbond or similar)

By the way, if the dimensions of our cabinet don't suit your purposes or perhaps the available timber, you might like to rearrange the enclosure's shape into something more convenient. Providing the the speaker cabinet's internal volume remains at 6 litres and both the tuning port's opening area (15cm^2) and its length (43mm) stay as specified, the speaker should deliver the same performance as in our prototype enclosure.

Also, while we used a low-cost Clarion speaker (from Jaycar) in our prototype unit, there's no reason why some other speaker with similar characteristics could not be pressed into service — provided that you're willing to experiment with the cabinet's tuning.

This is not as difficult as it might sound, since the tuning can be varied over a considerable range by simply changing the length of the 'shelf' that forms the top of the port.

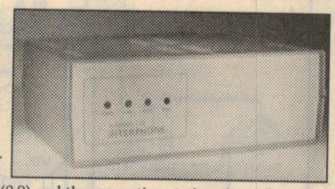
By initially making the length a little short, the box could be tuned by adding strips of timber to the end of the shelf while monitoring the results with a sound level meter (or say, a tape deck and microphone) or simply by ear, until you've reached a satisfactory result.

On the other hand, the amplifier's equalisation curve (the electronic 'tuning') should suit most speakers of this type — since by nature, the combination of a small rigid cone plus the additional 'whizzer' cone tends to produce a substantial peak in the midrange area. Of course, this aspect can also be 'tuned' by ear through altering the values of the filter components. ❖



Yet another year has passed us and now it is 1993. Once again we all at *ALTRONICS* thank you - our valued customer for your continuous support throughout 1992. Already this new year is promising to be bigger and better with the arrival of many new products in the coming weeks ahead. February marks the arrival of *ALTRONIC'S* 1993 catalogue which is supplied FREE inside this magazine, so be sure to get your copy.

Mini Home Telephone Exchange Kit



This great unit allows you to place calls on hold, intercom other extensions, answer calls from any extension and transfer calls. It is expandable up to 10 extensions, and is compatible with all DTMF (touch tone) telephones. Operation is as simple as pressing '*' to place a call on hold and press the extension number (0.9) and the respective station rings. Once answered you have a two way intercom with which you can announced call. To pick up the incoming call from hold press #. A neat feature is that all extensions will ring when an incoming call is placed on hold for 30 seconds so that it won't be forgotten. The basic kit is complete with power supply, case and facilities for 3 extensions. Extra extension boards allow expansion in multiples of 3. Fantastic for home or small office. No more shouting from room to room. Not Austel approved.

K 1430 Basic Kit **$189.00** K 1435 Expansion Board **$79.95**

Multi-Station Headset Intercom Kit



This multi-station headset intercom is designed to provide clear communication in high noise environments such as at race tracks and rock concerts. It is designed to operate with a headphone and mic combination. Each headset requires a station module. Stations are simply connected in a daisy-chain fashion. Up to 12 units (stations) can operate from the power supply. Features low noise circuity and compares equivalents. Mics can be switched on continuously at one time for hands free operation of all stations. Also includes visual and audio call function. Ideally suited to our C 9055 headset mic and the C 9070 noise attenuating Aviation Headset.

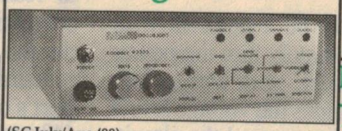
K 5250 Station Module **$74.95** K 5255 Power Supply **$64.95**

2 Way Active Crossover Kit K 5570 $19.95



(EA Jan 92)
This great new kit enables you to customise your sound system in your car or at home. The circuit simply connects between the audio source and the amplifiers. There are two outputs one for bass and another provides signal for the upper range. Thus each amp is dedicated to a frequency range (i.e. one for bass, one for midrange and treble). Because no passive crossover is required in the speaker one per channel is required. Operates on + and - 15V rails. The result is much better sound with less distortion.

Discolite Chaser & Colour Organ Kit



(SC July/Aug '88)
Add some colour to your next party. Great for parties, shop displays and special lighting effects. The Discolite flashes party lights on and off in beat with the music 4 light channels. Forward reverse and auto-reversing chaser patterns. Inbuilt microphone for beat triggering or audio modulation of lights. Front panel LED's mimic light display.

K 5805 **$159.00**

Beat Triggered Strobe Kit K 5790 $79.00



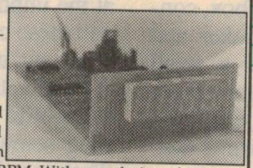
Flashes in time with the music or can run on own oscillator (variable speed). Output can be increased with two tube option.

Drill Speed Controller Kit K 6010 $39.95



Variable speed controller for 240V power tools including drills, power saws, engravers etc suitable for brush type tools up to 5A. Not suitable for globes or radiator heaters.

LED Digital Tachometer Kit



Great little kit that connects up to 4, 6 and 8 cylinder engines and gives a read out between 0 and 9900 RPM. With a resolution of 100 RPM. Requires only 3 connections (two to power and one terminal of the coil)

K 4320 **$31.00**

Flexible Loudspeaker Protection Circuit Kit



The 'protector' will protect your expensive loudspeaker from damage due to an amplifier fault or overdrive. Includes an intelligent 'de-thump' circuit the unit can run off your amplifiers supply rails or stand alone with an additional power supply.

K 5052 **$29.95**

Digital Storage C.R.O. Adaptor for P.C.'s Kit



This great kit enables a P.C. user to capture a waveform and zoom in to segments of interest then save them to disc. The unit has 32K of storage memory and a sampling rate of over 600K samples per second. Input level of up to 2.5 Volt. Full sampling rate between 15K s/s to over 600K s/s. Input impedance of 1M ohm.

K 2805 **$63.50** *NEW FOR '93*

K 2806 PC Software to Suit **$19.95**

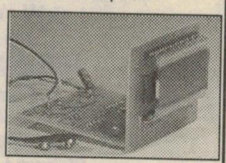
Capacitance Meter Adaptor Kit (SC Nov '87)



Simply plugs into your multimeter. Two ranges of .0022µF and 2.2µF.

K 2520 **$24.95**

3.5 Digit LCD Panel Meter Kit K 2528 $34.95



Ideal addition to power supplies, voltage meters, current, meters etc. It can be calibrated to accurately read 2mV, 2V, 200V. Requires 9 volt power supply. Programmable decimal point.

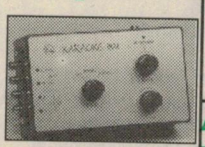
Ni-Cad Battery Discharger Kit



Designed to rid your nicad batteries of the memory effect and regain full recharge potential. It discharges your nicads correctly to enable a full recharge. Suits most battery packs. Great for mobile phones, battery drills, toys etc.

K 1640 **$24.95**

'Karaoke' Adaptor Kit



A fun gift for Christmas. With this project you can remove the lead vocals from almost any recording. Great way to liven up a party. Requires 2 x 9V batteries.

K 1170 **$34.95**

4 Digital Combo Lock Kit

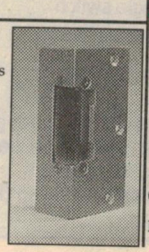


This great kit is ideal for security applications such as an ignition killer for cars. With an additional really it easily connects up to either a fuel solenoid or your car coil. A good way to protect your car.

K 1925 **$44.50**

Buy Both for **$75.00**

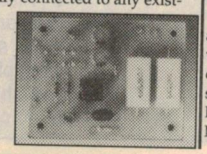
Door Strike



This device easily connects up to the combo lock kit giving security and keyless easy access to your room. Comes supplied with two facial plates. Requires 12V DC.

S 4390 **$39.95**

Amp Bridging Module for Stereo Amps Kit



With this circuit it is possible to quadruple the output of your stereo amplifier by turning it into one high powered mono amplifier. It uses one I.C. and is easily connected to any existing two channel amplifier. Harmonic distortion. Less than 0.001% @ 8V RMS.

K 5565 **$16.80**

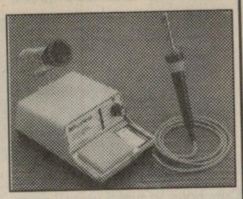
Sub-Woofer Adaptor Kit K 5560 $29.95



Get an amazing bass improvement from your stereo system. This fantastic adaptor simply "samples" your stereo amp output and provides a single channel output to feed a separate sub-woofer amp. Requires 12V AC or M 9020 plugpack.

AUSTRALIA WIDE • Jet Express • ALTRONIC COMPONENTS

Electronic Controlled Soldering Station

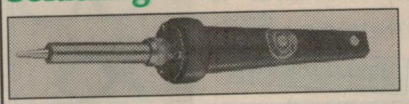


The micro T 2440 Soldering Station offers the ultimate in controlled hand soldering with a range of pre-selected temperatures. Zero crossing switching protects your components with a 24V element. Excellent soldering results with our earthed chrome plated iron clad tip.

T 2440 NORMALLY $159.00

This Month Only $139.95

Variable Temperature Soldering Iron *



The next best thing to our soldering station is our temperature adjustable handheld soldering iron. Temperature is regulated via a screw driver adjustment on the handle. (Range 250°C to 450°C). Ask about our range of tips to suit.

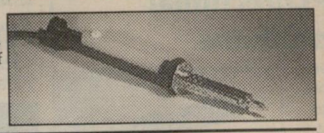
T 2446 NORMALLY $49.00

Excellent Value

This Month Only $39.95

Multiple De-Solder Tool

An excellent companion to any of our irons. If you need to de-solder you need one of these.



T 1250 $45.00

De-solder Pump

Self cleaning plunger. Long life teflon tip. Double diaphragm



T 1240 $11.95

T 1241 Spare Tips $2.35

De-soldering Braid *



2 sizes available. All one low price.

T 1232 4mm

T 1234 3mm

Both $3.50

Solder

200g rolls. Multicore.

T 1200 1.0mm $7.00

T 1202 0.7mm $8.00

Switches

SPST chassis mount. With built in 240VAC Neon light. .99¢ ea

S 3218



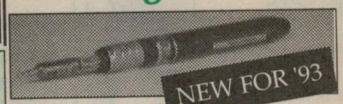
Tuning Meters

Panel Mount $3.45

Q 0600



New Altronics Gas Soldering Iron



NEW FOR '93

The latest in portable gas soldering irons would have to be this iron. This great new model is excellent value Uses standard butane gas as fuel. Easy to use. Easy to refill.

Replacement Tips

T 2481	1mm Tip	$5.95
T 2482	2mm Tip	$5.95
T 2483	3mm Tip	$5.95
T 2484	4mm Tip	$5.95
T 2485	Tip Wrench	$3.50
T 2486	Cutter Tip	$5.95
T 2487	Hot Blower	$5.95
T 2488	Blow Torch Head	$5.95
T 2448	Gas Refill	$6.95

T 2480 $34.95

Fans

Fantastic computer type fans for replacement or additions for extra cooling of power supplies, amps etc.



F 1020 240V 80mm² $25.50

F 1030 240V 120mm² $25.40

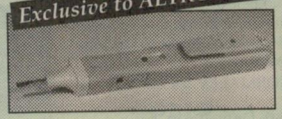
F 1040 24VDC 120mm² $23.90

F 1050 12VDC 80mm² $17.50

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Just Arrived - Multi-Purpose Electrical Tester

Exclusive to ALTRONICS

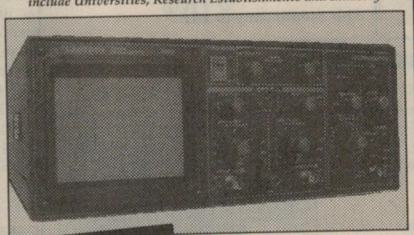


This fantastic gadget will test a myriad of electrical and electronic components. It is simple to operate and is sure to amaze you with it's uses. Best of all, it's priced to make it a must for every technician, electrician and enthusiast. It is not much larger than a fat pen and fits easily into your pocket. It tests continuity/resistance (with 100MΩ, 50MΩ and 5MΩ ranges), with buzzer and/or LED indication. Ingenious design uses your hands and body to check continuity - by a metal tab imbedded into the handle (for one point of body contact), placing the probe tip onto the component being tested and touching the other side of the component with your other hand! Dead easy to use. Will check fuses, light bulbs, wiring, elements, speakers, diodes/LEDS, transistors, transformers and the list is endless. Add to this a high voltage AC test (by touching the contact with the probe tip) and a non-contact high voltage test (check for wires etc. behind or inside a wall/cable etc etc.) this would have to be one of the most versatile and value for money electronic tester available!

Q 1250 Amazing Low Price $17.95

Famous Labtech 20MHz Dual Trace Oscilloscope

Over 3000 now in service throughout Australia - Our customers include Universities, Research Establishments and Industry



This model is a dual trace 20MHz oscilloscope using high brightness CRT. The vertical amplifiers have high sensitivity of 5mV/div and a frequency characteristic response with smooth roll off exceeding 20MHz. The TV sync. signal operator circuit is provided to ensure stable observation of video signals. Triggering is obtained by sampling the AC power waveform, external waveform or internally generated trigger. Requires Probes.

Q 0156 $649.00

Free Freight Anywhere in Australia Included with this CRO

High-Tech Remote Car Alarm

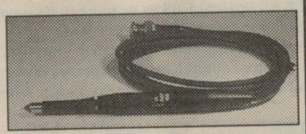


This amazing model features just about everything you could imagine! Multi-function keyring remote control will arm and disarm alarm (and activate central locking if fitted), chirp the horn, turn on the car headlights, panic and even open the boot (if actuator fitted). One remote can control two alarms (in two cars). Other features include starter inhibit, valet mode, central locking interface, flashes car indicators when tripped, auto reset, user programmable options plus much more.

S 5230 $249.00

Cro Probes

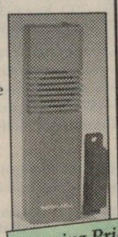
Ideally Suited to Q 0156 (2 required). Superb quality DC to 80MHz. Max 600 volts DC. Lead length approx. 1.5m.



Q 0175 $49.95 ea

Door Alarms

With this simple device you can monitor any door in your house. This two piece alarm consists of a control box and a magnet. The magnet simply onto the door frame while the control box is mounted on the door, so that they are opposite when the door is closed. Easy to use on/off switch. Built-in beeping buzzer sounds when tripped. Requires 9V battery.



S 5315 NORMALLY $19.95

This Month Only $7

Amazing Price!

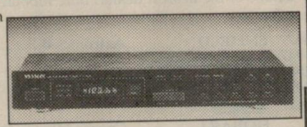
Satellite Siren S 5235 $68.45

This self contained and compact unit can deliver a massive 120dB. It connects via 3 wires to any alarm system that has an output which is normally negative. Will sound if the wires are cut. Includes built-in batteries, charging circuit and arm/disarm keyswitch.



AM/FM PLL Tuner

This great tuner is the ideal add on or up-grade for your sound system. Features auto station seek and 10 memories.



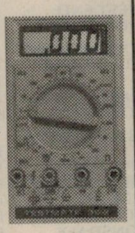
A 2210 NORMALLY $229.00

This Month Only $199.00

17 Range Economy Digital Multimeter

A great meter just for basic use. No fancy bits and pieces that you won't use.

Includes: DC Volts • AC Volts • DC Amps • Resistance • Diode Check • Load test on battery check etc. etc.

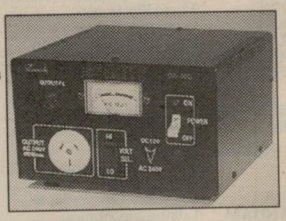


Q 1056 NORMALLY $53.45

This Month Only $49.95

300 Watt Inverter

This nifty inverter converts 12 Volts DC to 240 Volts AC. Includes an on/off switch and a light & heavy load switch with metered output. Works well with most electrical equipment.



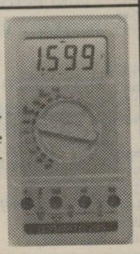
M 8120 NORMALLY $249.00

*

This Month Only $229.00

Auto-Ranging Digital Multimeter

This neat digital multimeter has all the most used ranges. • Extra large LCD display • Auto ranging • Continuity check • Diode test • Overload beeper indication • Range annunciation • High impact case • One easy to use control • Low battery indication • DC Voltage • AC Voltage



Q 1072 $89.00

Q 1065 Carry Case to Suit $12.50

ALTRONIC COMPONENTS

PHONE ORDER - FREECALL 008 999 007

AUSTRALIA WIDE • Jet Express • ALTRONIC COMPONENTS

Uni-Directional Microphone



Great general purpose and entertainment mic. 600Ω. Fitted with 6.5mm plug. (Mic holder not included)

C 0360 NORMALLY $39.50

This Month Only $29.95 *

Auto Wire Strippers



Automatically adjusts to insulation and wire diameter.

T 1520 NORMALLY $10.95

This Month Only $8.95

CD Cleaner



We are clearing out our CD Cleaners. These cleaners use the correct motion for removing small surface scratches and general dirt and grime.

A 9220 NORMALLY $17.95

Huge Reduction!

This Month Only $7.95

8" PECC Woofer

A high grade speaker with fibre impregnated paper cone, aluminium voice coil and vented magnets.



Rated Power....60W RMS
Impedance.....8 ohm
RES Frequency60Hz
Sensitivity.....98dB
QMS 1.81
QES.....0.38
QTS.....0.31
VAS (L) 27.8

C 3024 NORMALLY $69.00

This Month Only $54.95 *

Palm-Grip Series Hand Tools

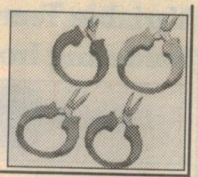
A must for all toll boxes.
T 2710 Flat Nose Pliers
T 2720 Needle Nose Pliers
T 2730 Curved Needle Nose Pliers

ALL NORMALLY $9.95 ea

This Month Only $7.95 ea

Bargain Priced!

BUY ALL FOR $18



Super Large Instrument Cases

Designed to house amplifiers, inverters, power supplies micro-processor equipment etc. Built-in mounting posts for PCB's, transformers etc. Ventilated for efficient air-flow cooling. Extra tough, Super finish front and rear panels. 3 colours available

H 0490 Grey Case
H 0491 Black Case
H 0492 Blue Case

All NORMALLY $39.95

This Month Only $29.95



Massive 355x250x122mm
Fantastic for Power Supplies/Amps etc.

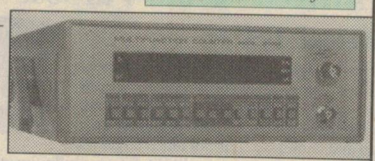
1 GHz Frequency Counter

As Used in Tafe Colleges, R&D, and Industry

This multiple-function 10Hz to 1GHz counter model features 8 digit LED read-out, small size, light weight and highly stabilised crystal oscillator for accurate measurement.

Q 1535 NORMALLY $499.00

This Month Only $449.00



Round Piezo Tweeter

95.3mm in diameter Piezo Speaker with a frequency response of 3KHz to 40KHz. Great Value

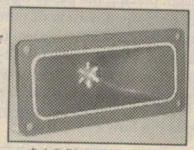
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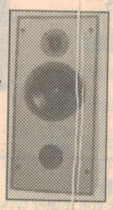
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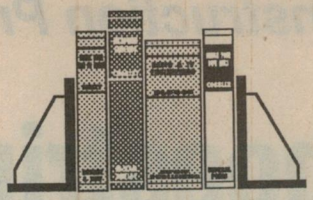
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NEW BOOKS



Basic electricity

ELECTRICAL FUNDAMENTALS, by Peter Phillips. Published by Thomas Nelson Australia, 1993. Soft covers, 255 x 180mm, 161 pages. ISBN 0-17-008816-2. Recommended retail price $14.95.

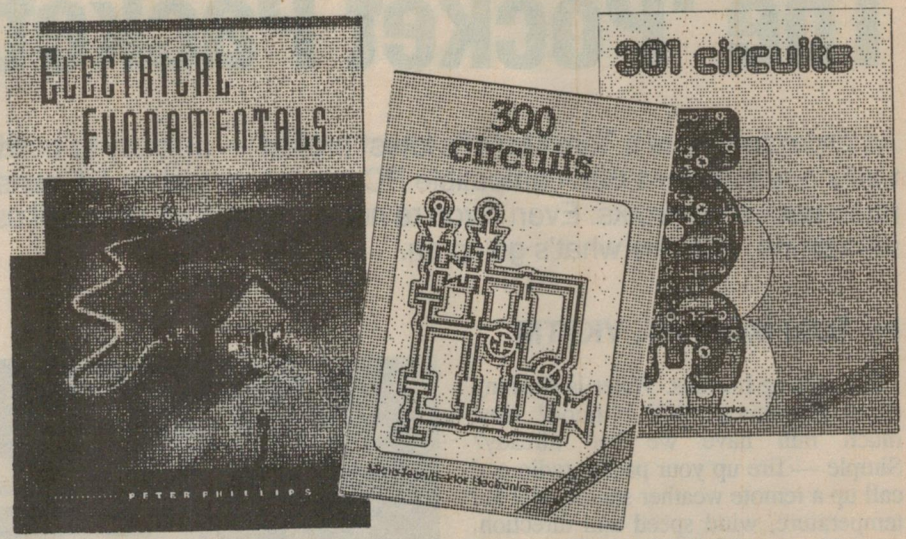
Yes, the author of this book is indeed our very own contributing technical consultant Peter Phillips, who as some readers may know is also Senior Head Teacher of Electronic Trades at Sydney Institute of Technology. Peter has over 18 years experience in TAFE teaching, and has written this particular volume specifically for people studying the TAFE 'National Module' NBB08, which is an introduction to basic electrical concepts. I gather that this module now forms part of many TAFE courses which touch upon electrical fundamentals.

Peter tells me that the book simply couldn't have been produced to sell at the commendably low price shown, if he hadn't been able to take advantage of modern desktop publishing technology. As well as writing all of the text, he also drew most of the 200+ diagrams, and after it had been edited, assembled all the pages himself on a PC, using *Ami Pro* running under *Windows 3.0*. It was then all directly typeset as pages, using a Linotronic typesetter at 1200dpi, before sending it off to the publisher.

The end result certainly vindicates this approach, and Peter has every reason to be proud of it. His text not only explains the concepts clearly, but is very nicely augmented with many helpful and easily understood diagrams. And everything is laid out cleanly, so that the reader is led smoothly along the learning path with an absolute minimum of obstacles.

In short, it seems like a very well produced text on basic electrical concepts, and one which should be of value not just to people doing TAFE courses including module NBB08, but almost anyone looking for an introduction which makes no assumptions about 'prior knowledge'. Congratulations, Peter.

The review copy came from Thomas Nelson Australia, of 102 Dodds Street, South Melbourne 3205. However copies should be available from most of the larger general bookstores and TAFE college co-operative bookshops. (J.R.)



Circuit ideas

300 CIRCUITS and 301 CIRCUITS. Published by Micro-Tech Publications, 1992. Soft covers, 212 x 146mm, 265 pages and 344 pages, respectively. Recommended retail price, $19.95 each.

These two books provide compilations of circuits published originally in the Dutch magazine *Elektor Electronics*, and are designed for the home constructor. As quoted in the introduction to Book 2, the book is 'composed of 301 assorted circuits, ranging from the simple to the more complex designs, described and explained in straightforward language. An ideal basis for constructional projects and a comprehensive source of ideas for anyone interested in electronics. In a nutshell, something to please everybody.'

There are some circuits built around discrete components, though most involve ICs. There are transistor testers, various sound effects (including a bagpipe doorbell!), alarms, model railway add-ons, wind speed indicators, thermometers, chargers, doorbells, etc. As the publisher so rightly claims, 'something to please everybody'.

Each circuit has a schematic diagram and a reasonably detailed explanation of how the circuit works. Of necessity, these explanations have been kept as brief as possible, but they should be quite adequate for anyone with a reasonable electronics background. Quite a few circuits also give a PCB pattern, to allow constructors to etch their own boards.

Each book lists the circuits in its contents, though only Volume 1 has an alphabetical index as well. This omission from Volume 2 is the only criticism I have of the two volumes.

Quite a bit of technical information is given in appendices, including pages of IC pinouts and transistor characteristics. For many applications, specific transistors and diodes are not required, and this is clearly pointed out by using abbreviations like TUN or TUP (transistor, universal, NPN or PNP) on the circuit schematics concerned.

The books are great if you are chasing a circuit for a specific application, or just want some interesting design to build. Of course, you must remember that such books are compilations of many people's submissions — not necessarily tried and tested circuits!

Since receiving these two volumes to review, a further two collections have been printed, not surprisingly called '302 Circuits' and '303 Circuits'.

The review copies came from Jaycar Electronics. The Jaycar catalog numbers for the four volumes are BM-2470 — BM-2473, and all four volumes are available from Jaycar stores for $19.95 each. (P.M.) ❖

Construction Project:

Shoestring packet radio: The 'Pocket Packet' modem

As promised, here's Tom Moffat's latest project — an easy to build, low cost modem which turns virtually any standard IBM-compatible PC into a terminal for full transmit-receive operation on amateur radio packet networks. Even if you're not a amateur you can still use it to 'eavesdrop' on packet conversations, and see what's going on.

by TOM MOFFAT, VK7TM

It's raining buckets. Water is sloshing down the streets. Will it flood? How much rain have we had already? Simple — fire up your packet radio and call up a remote weather station. Get the temperature, wind speed and direction, rainfall — as of RIGHT NOW, not as of 9:00 this morning. It's yet another snazzy application of packet radio that wasn't even around, in Hobart at least, when last month's 'introduction' article was written.

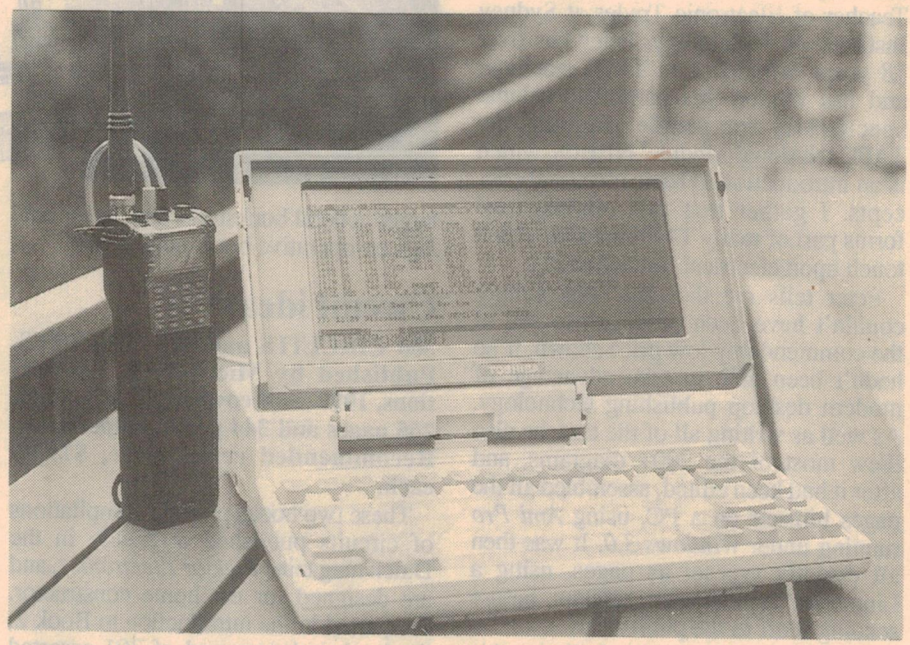
It's happening that fast, really. This packet radio thing is growing in leaps and bounds, a technology wildfire. Some of the screen photos show the remote weather station in action. What will be next?

This month we present full details of our Pocket Packet modem project, as well as an overview of the BayCom and SP software, either of which can be used with the modem.

Just to make the situation perfectly clear, if you have a VHF radio and an IBM-PC type computer, the Pocket Packet modem and one of the software packages are *all you need* to get up and running on packet radio. You do NOT need to spend several hundred dollars for a TNC (terminal node controller).

This is not a 'stripped down' packet radio scheme; its performance is every bit as good as that provided by 'big' systems. In fact some of the popular dedicated TNC's use exactly the same TCM3105 modem chip used in the Pocket Packet. The only difference with a stand-alone TNC is that it uses an external 'black box', with its own microprocessor and software in read-only memory.

In our system, ALL the software resides within the IBM-PC itself — and our 'black box' has shrunk to the size of a pack of cigarettes. It even draws its operating power from the PC itself, and if used with a laptop computer and a handheld radio, the Pocket Packet system can be used fully portable. Try THAT with a big TNC!



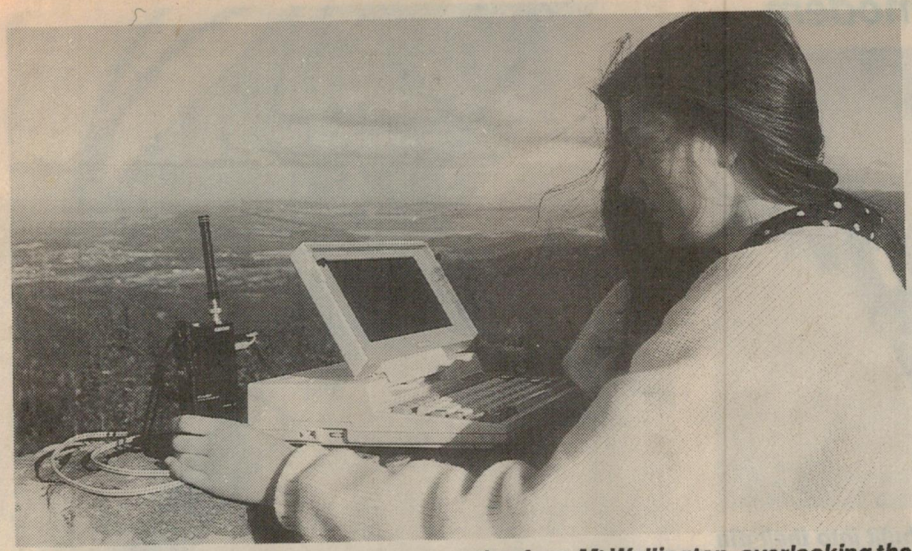
A Toshiba laptop running Baycom software through the Pocket Packet modem and an Icom 24AT transceiver.

If you are a licensed radio amateur you can transmit and receive on packet. If you don't have a licence, you can still connect the Pocket Packet modem to a VHF scanner and monitor everything that goes on in this fascinating mode of radio communication. It is quite likely that by the time you read this, it will be very easy to get a grade of amateur licence which will allow you to transmit and receive packet on VHF. If you do get a ham licence, the Pocket Packet modem has all the transmitting bits ready and working. The basic concepts of packet radio were discussed in detail in last month's *Electronics Australia*.

High-Tech Tasmania, of 'Listening Post' fame is offering a kit for the Pocket Packet project via mail order for $79.00 posted. Full ordering details are at the end of this article.

What it does

Basically what the Pocket Packet device does is translate digital high and low signals from the computer into high



The Pocket Packet portable station operating from Mt Wellington, overlooking the southern suburbs of Hobart.

and low pitch audio tones that can be sent instead of voice signals on an FM transceiver. This is the 'MO' or *modulator* part of the 'MODEM'. The 'DEM' or *demodulator* part does just the opposite — it accepts high and low audio tones from the radio and converts them back into high and low logic levels for the computer.

The conversion is necessary because you can't just pour 5V or 12V logic signals into a radio's microphone on one end, and expect 5V or 12V to come dribbling out the speaker of a radio across town. There is no 'DC path', so the signal sent by radio must be AC; that is, audio. Modems are almost universally used along telephone lines, by the way, even when a DC path exists.

Packet radio data on VHF is transferred using the 'BELL 202' standard; 'Bell' being that mother of all American telephone companies 'Ma Bell', and Alexander Grahame's namesake. The '202' is the standard that was developed after '201', I guess. The standard simply specifies that certain tone frequencies are to be used with certain baud rates (bits-per-second transmitted). VHF packet radio uses 1200 baud, and the BELL 202 standard tones for this baud rate are 1200Hz for Mark (logic high), and 2200Hz for Space (logic low). The terms 'Mark' and 'Space' come from the old teletype days, or even the Morse code days before that.

Knowing WHAT the Pocket Packet modem does, we can now discuss HOW it does it.

The circuit

Perhaps it is appropriate to introduce the star of the show first: the TCM3105 modem-on-a-chip. This beast has what would seem to be a simple function. You shove DC logic levels into one pin, and high and low audio tones come out of another pin. Or if you shove high and low audio tones into yet another pin, DC logic levels come out of still another other pin.

But life within the TCM3105 isn't really that easy. For one thing, there are no passive or resonant components associated with the chip, other than a crystal. Yet the audio that comes out of it is a lovely, low-distortion sine wave which is synthesised within the chip. And when the sine wave switches from the low to the high frequency and vice versa, it does so only as it passes through zero. This form of switching is said to be 'phase coherent', and it's provided to minimise transients on the output.

The synthesiser begins with the 4.443MHz crystal frequency and divides it down by a ratio controlled by inputs to the TRS, TRX1, TRX2, and the TXD (transmit data) pins. So all the data logic line from the computer is doing is adding its own two cents' worth via TXD to the other 'programming' lines of the synthesiser, changing the programming and with it the output frequency, 1200 times a second.

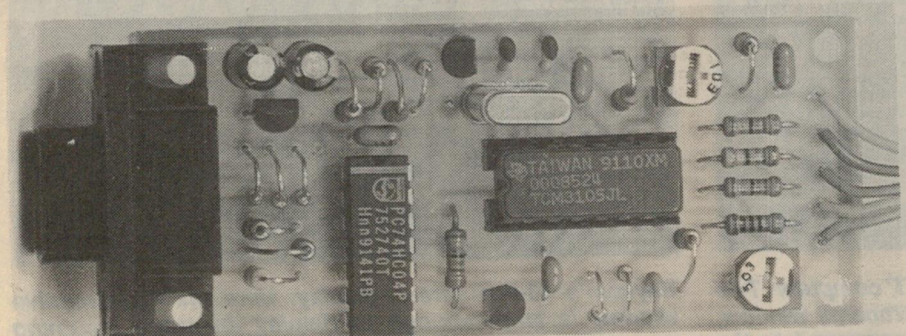
As for audio coming into the chip from the radio, its frequency is converted to a voltage, which is then fed to a comparator. If the frequency-proportional voltage is higher than a preset level, the comparator produces one logic state; if it's lower than the preset level, the comparator flips the other way. The 'preset level' is supplied from outside the IC from RV1. We adjust this during the setup procedure.

But, as before, things aren't as simple as they seem. Before the audio frequency is converted to a voltage, it is first applied to an on-chip digital low pass filter and a digital receive filter. Next comes a group delay equaliser to correct phase distortion, and automatic gain control. There's also a carrier detect facility which we don't use in this application, and finally the signal is demodulated. The idea of all this complication is to dig signals out of noisy conditions with the lowest possible error rate. It works beautifully.

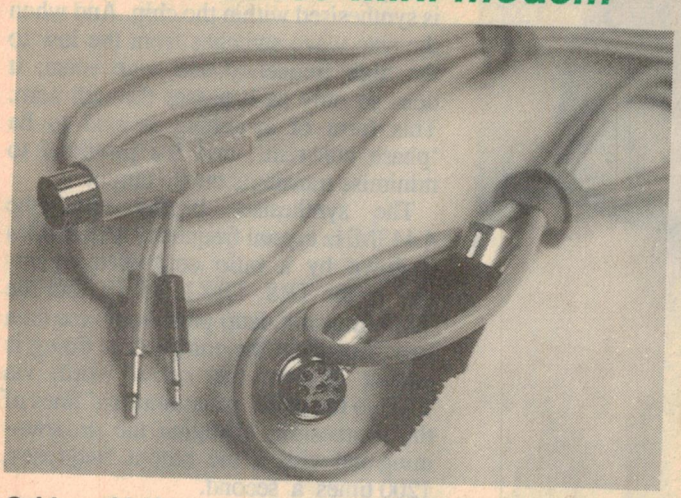
So the TCM3105 isn't just your run-of-the-mill chip, even though it looks like a simple little 16-pin dual inline IC. The application notes refer to it as a 'system', but I'd call it a data-processing factory. The TCM3105 doesn't come cheap, but it replaces an enormous number of discrete components. If you drop it on the floor while building the kit, don't step on it or you'll be shedding some crocodile tears!

OK; we're outside the TCM3105 now, onto the circuit board. Let's look first at the TCM3105's synthesiser programming. The chip is capable of several different operating modes, and for BELL 202 at 1200 baud, TXR1 and TXR2 must be grounded.

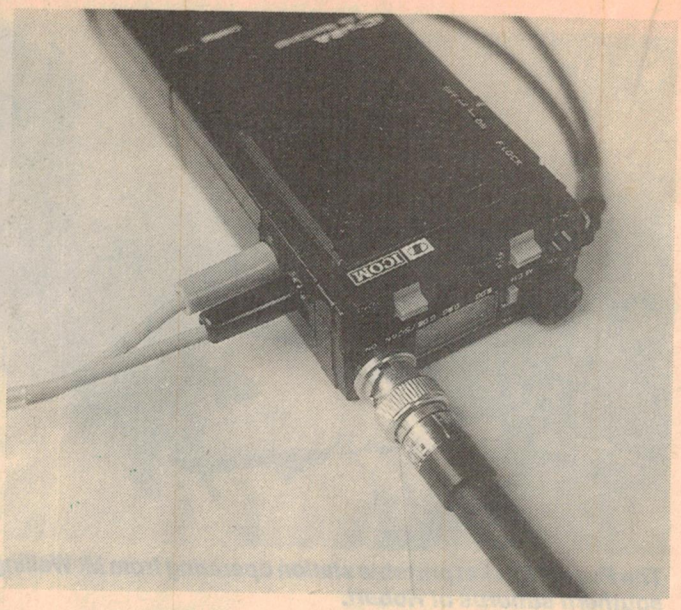
But the TRS programming pin must be fed an upside-down version of the output from the CLK pin, which in this case is a 19.11kHz square wave. One of



The complete PC board for the author's Pocket Packet modem, slightly larger than actual size. The 9-pin DB connector on the left goes to the computer, while the wires at the right hand end go to your transceiver.



Cables with the transmit code selection built into their din plugs. The cable at upper left is for various handhelds, with separate mic and ear plugs. The cable at lower right is for Icom mobile/base transceivers, with a special Icom microphone connector.



The Pocket Packet radio cable connected to the Mic and Earphone sockets of the Icom Micro-24 handheld.

the 74HC04 inverters, IC2d, takes care of this.

Feeding upside-down clock pulses into a programming pin, while at the same time feeding digital data into another, seems a pretty funny way to do things. But that's nothing — some of the other modes require the clock to be inverted and divided by eight as well — we got off easy.

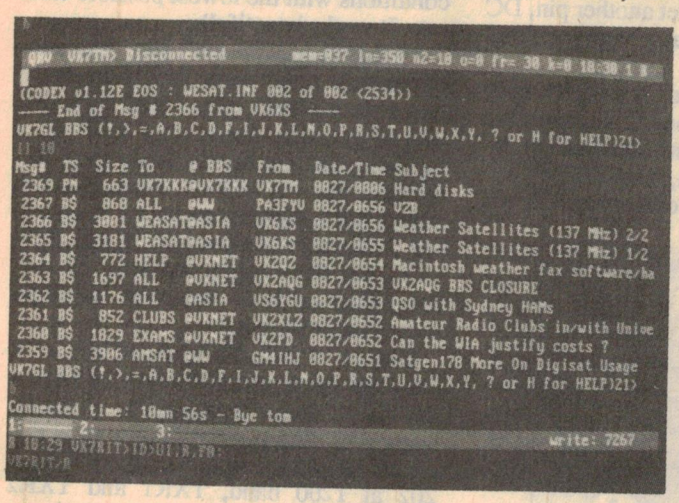
With a 4.433MHz crystal oscillator running in one place and 19.11kHz signals streaming somewhere else, and analog and digital data flowing in and out of the same chip, the PCB had to be very carefully designed to prevent instability. Attempted construction of the Pocket Packet modem without the correct PCB is certainly not recommended...

Now let's look at the connections to the computer. Three signal paths are provided — data to be transmitted via the modem, data received from the modem, and a signal to switch the radio's transmitter on and off. Even though the signals connect with the computer's serial port, they do NOT use the port's lines that are normally provided for data. The lines carrying signals to and from the Pocket Packet modem are the serial port's 'handshake' lines. As for the serial port's normal data lines, TXD (transmit data) forms part of the modem's power supply, and RXD (receive data) is not used at all.

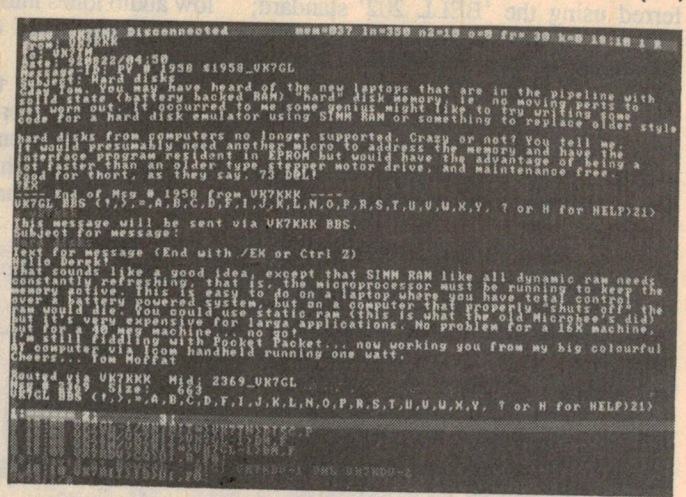
Every signal to and from the computer is upside-down from what it should be for the modem, so each line must go through an inverter. The 'normal' serial port line's data levels are +12 volts and -12 volts, although this may vary considerably from computer to computer.

The two outputs from the computer are connected to the inputs of 74HC04 inverters (IC2a and b), which in theory should not be subjected to voltages less than zero or greater than +5. But with our +/-12 volts we are cheating a bit, relying on the protection diodes within the inverters to limit the voltages.

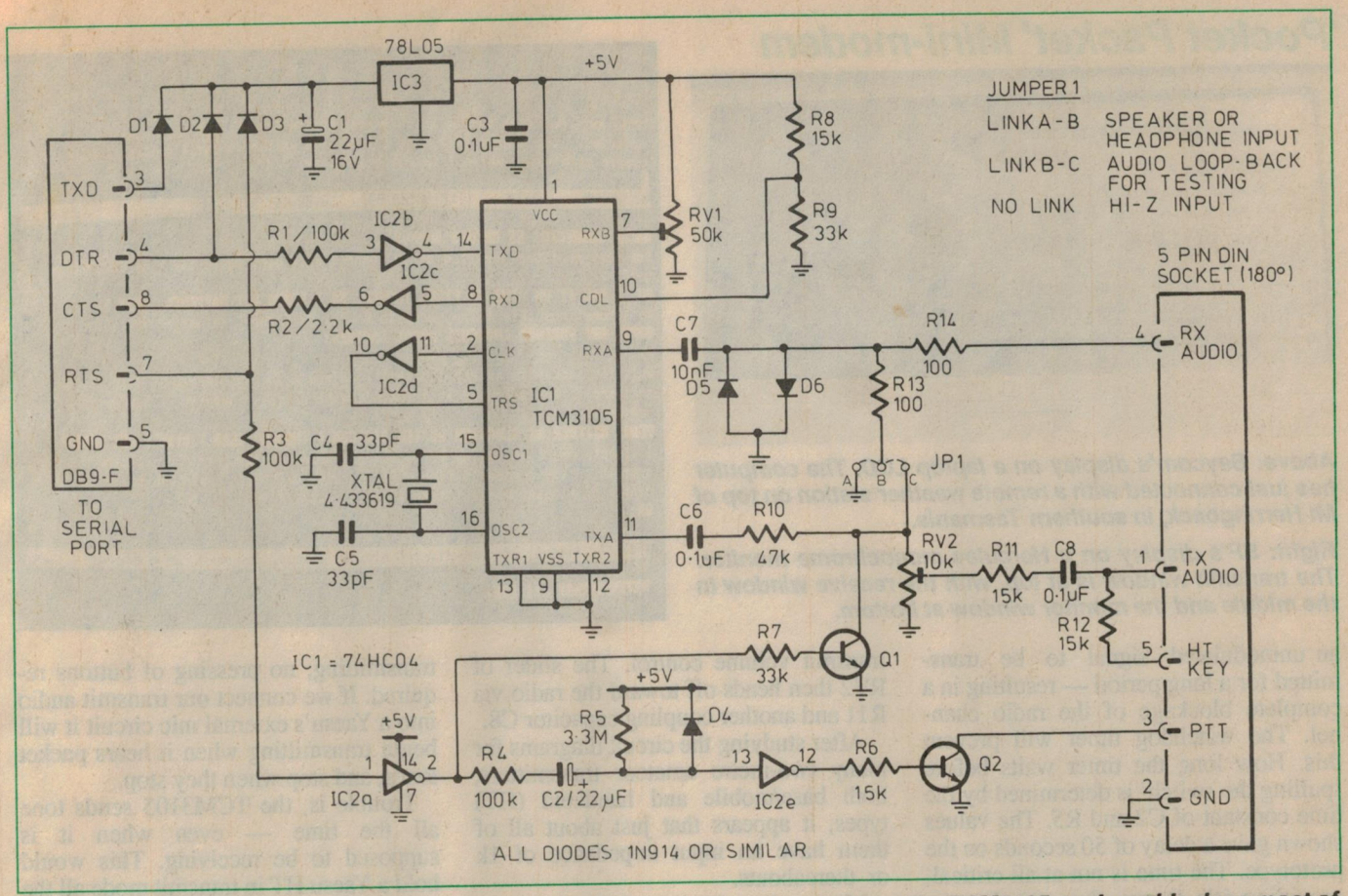
These are tiny diodes with tiny current handling capacities, so we have included 100k series resistors (R1,



Baycom's 25-line screen display, on an 'AT' computer. Two lines above the upper status bar are the transmit window, which only contains a 'b', a 'goodbye' command to the bulletin board. The large receive window shows a listing of the 10 most recent items available from the bulletin board.



Baycom's 43-line screen display. Here the main receive window is large enough to display an entire incoming message, and the outgoing reply below it. Below the lower status bar is the monitor window, temporarily extended to six or seven lines.



The circuit for the Pocket Packet modem is quite straightforward, as you can see. The TCM3105 modem chip does most of the work, with its power derived from the computer serial port lines via diodes D1, D2 and D3.

R3) to limit signal currents to the microamp range.

Going back toward the computer, received data from the TCM3105 goes through another inverter (IC2c) and then a 2.2k current limiting resistor. The computer input expects to see +/-12V, but here it only gets the 0/+5 volt levels from the inverter. This is quite OK — just about every serial port in the land will work happily with these voltages.

As you know, the Pocket Packet modem draws its minuscule operating power from the serial port. This is where diodes D1, D2, and D3 come into play. The diodes prevent the negative excursions of the computer serial lines from reaching the modem's power supply, even though all voltages are still passed on to the inverters. But when any of the lines goes positive, the diode connected to it conducts and passes some energy into the filter capacitor C1.

It's like three little men all standing there bucketing water into a storage tank. One fellow on his own is not too effective, but the three working together get the job done.

As mentioned above, the computer's 'proper' data output is not used for data in this application; its sole purpose is to pump volts into the storage capacitor C1. The computer does not have direct control over the state of TXD, this is hardware-controlled by the serial communications chip.

So the computer just sends a never-ending string of ASCII nulls to the chip. The null character consists of eight low data bits. When they come out of the serial port upside down they are high data bits, so lots of juicy current flows into C1.

The computer's RTS line controls the radio's push-to-talk circuit, and when the computer is transmitting RTS is high. It's another source of current for C1, via D3. And DTR jumps up and down with transmitted data, feeding still more energy into C1 via D2 during the times it is high. When the computer is receiving the RTS line (push-to-talk control) goes low. But it is replaced by the DTR (transmit data) line which stops jumping and comes to rest in the high state. So it is now feeding energy full-time into C1 via D2.

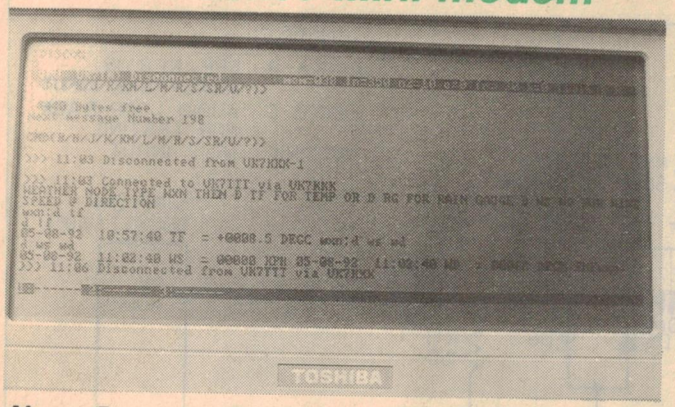
So at least two lines are feeding current into C1 at any time, with DTR also joining in on its high excursions while the computer is transmitting. C1 charges up nicely to whatever voltage is the 'high' level in that particular computer. C1 is tied to a 78L05 five-volt regulator, and *voila*! we've got a free-as-the-wind five volt power supply for Pocket Packet.

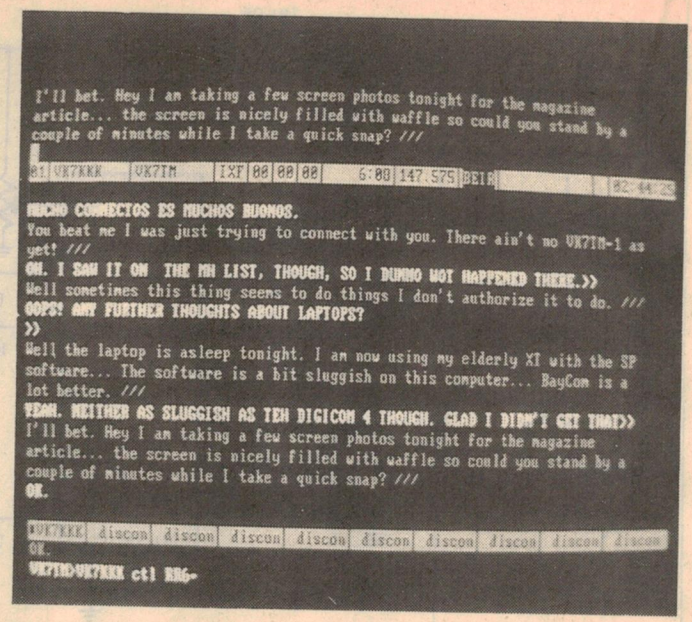
This scheme of course requires certain trickery within the software, and both BayCom and SP allow for it. So the design of the power supply is pretty well dictated by the software. The arrangement is quite unconventional, but it's in successful use all over the world. In the unlikely event it doesn't work on YOUR computer, you can leave out diodes D1, D2, and D3, and connect an external supply of 7 - 15 volts or so directly between ground and C1. The current consumption is very low, and for portable use a 9V transistor battery should last a long time.

Tracing the push-to-talk line from RTS past its inverter, we come to a collection of components R4, C2, R5, and D4. These make up a 'watchdog timer' which cuts off the transmitter if the computer holds RTS high for longer than a minute or so. It is quite possible for this to happen if the computer crashes.

Since it is possible that the Pocket Packet system could be run as an unattended station, a crash could cause

'Pocket Packet' Mini-modem





Above: Baycom's display on a laptop LCD. The computer has just connected with a remote weather station on top of Mt Herringback, in southern Tasmania.

Right: SP's display on a Hercules monochrome monitor. The transmit window is at top, with the receive window in the middle and the monitor window at bottom.

an unmodulated signal to be transmitted for a long period — resulting in a complete blockage of the radio channel. The watchdog timer will prevent this. How long the timer waits before 'pulling the switch' is determined by the time constant of C2 and R5. The values shown gave a delay of 50 seconds on the prototype. The time is not at all critical, providing it's longer than the longest legitimate packet transmission.

Now let's move around to the audio side of the circuit, where RXA (receive audio) and TXA (transmit audio) connect with the TCM3105. The audio path from the radio to the chip first hits R14, meets a junction with R13, and is then clamped with diodes D5 and D6. The diodes are there to prevent an excessively high audio level from blowing up the TCM3105.

Apparently it is quite delicate in this regard. The audio is then fed into the chip by coupling capacitor C7.

If the audio comes from a low impedence source in the receiver such as a speaker or earphone connector, the bottom end of R13 (B) should be connected to ground (A). R13 and R14 then become a 2:1 voltage divider, with a 200-ohm load impedance for the radio. If audio is taken from a higher impedence source, such as the 'record' output of a scanner or receiver, then the connection at (B) can be left open, providing a high impedence input to the modem. For modem testing and alignment, (B) can be connected to (C) to loop the output signal back to the input.

The modem's transmit audio comes from the TXA output of the TCM3105, through coupling capacitor C6 and resistor R10, to the top of RV2 which is the transmit volume control. The slider of RV2 then heads off toward the radio via R11 and another coupling capacitor C8.

After studying the circuit diagrams for many two-metre amateur transmitters, both base/mobile and handheld (HT) types, it appears that just about all of them have an input impedance of 1k or thereabouts.

Many radios also have DC voltages on their microphone lines, either to provide power for an external mic preamp, or to act as push-to-talk control. C8 blocks this DC, and is large enough to allow reasonable low frequency response.

R11 acts to roughly set the audio level so that the trimpot RV2 is near the centre of the range when correctly adjusted. And, would you believe, 15k for R11 has proved to be just about right for every transmitter I've yet tested with Pocket Packet. In fact I haven't even needed to adjust the trimpot, once it was set up for my Icom IC3200 VHF transceiver. The modem has been hooked to at least half-a-dozen handhelds by now, and every one has worked fine without touching RV2.

Now to the interesting matter of R12. This provides push-to-talk control for handheld radios: short the microphone line to ground through the resistor and the radio begins transmitting. Remove the short and the radio reverts to receive. To use Pocket Packet with most handhelds it is only necessary to loop the line labelled 'HT Key' back to the PTT line, from Q2.

As well as the 'DC on the mic lead' method of keying, Yaesu handhelds have a VOX (voice operation) circuit. While using a headset/mic you need only say something and the radio will begin transmitting; no pressing of buttons required. If we connect our transmit audio into a Yaesu's external mic circuit it will begin transmitting when it hears packet tones, and stop when they stop.

Trouble is, the TCM3105 sends tone all the time — even when it is supposed to be receiving. This would hold a Yaesu HT in transmit mode all the time, so we have provided transistor Q1 to put a stop to it. The base of Q1 is connected back to an inverted version of the PTT control from the computer, and when the computer goes to receive mode the transistor simply shorts the transmit audio to ground.

The TCM3105 application notes specify a 50k load impedance for the chip's TXA line, and the 47k resistor R10 provides this even when the transistor is shorted. When the transistor is not conducting the load impedance is then closer to 60k through RV2 — quite close enough to the design impedance. This audio switching works remarkably well, and it has absolutely no effect on the quality of the audio during transmission.

So to key a Yaesu handheld transmitter it is only necessary to connect the modem's transmit audio to the radio's mic input; the connection between HT Key and PTT is not needed. When the computer stops transmitting there is a short delay before the radio's transmitter goes off. This VOX DELAY is purposely designed into the radio to prevent it snapping on and off between speech syllables. The short delay seems to have little effect on packet transmission.

I have noticed that handhelds are a little slow to switch to transmit once the HT Key line has been pulled low. Luckily the software allows you to adjust the

time that synchronising 'flags' are sent before data actually starts flowing. The value is known as TXDELAY, and it can be set quite easily with both the BayCom and SP software. The default TXDELAY is around 22ms; set it for 500ms or so (half a second of flags) and HT's will work fine.

Transmitter keying is more conventional for non-handheld radios with separate push-to-talk lines. The open collector of Q2 is connected directly to the radio's PTT, which is usually one of the pins within the microphone connector. When the computer transmits, the PTT is pulled to ground.

The timebase for the TCM3105 modem chip is provided by the 4.33MHz crystal, connected directly to the chip along with a couple of loading capacitors. The frequency is not terribly critical, so no adjustment is provided.

R8 and R9 form a voltage divider to set the modem's carrier detect level to the 3.3V specified as 'typical' in the TCM3105 application notes. The carrier detect facility is not actually used in this application, since the software determines if signals are present from activity on the receive data input.

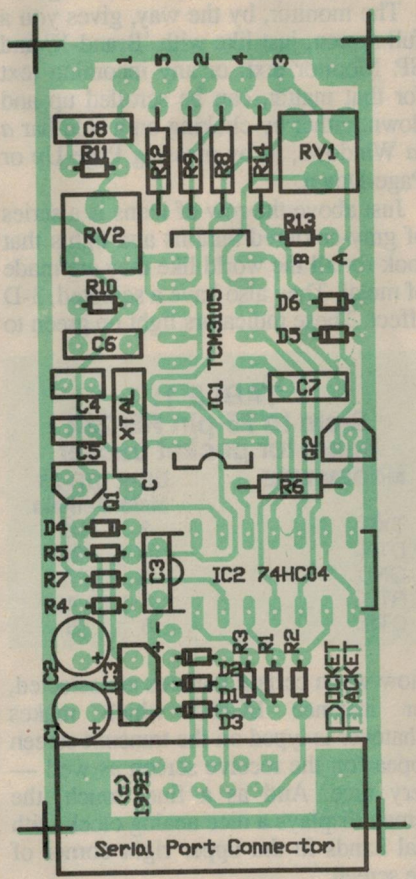
Nuts and bolts

The Pocket Packet circuit board is quite small, measuring 1.3 x 3 inches (PCB artwork uses 0.1" increments, not metric). The size was chosen to fit into the smallest standard 'Zippy-Box', measuring 28 x 54 x 83mm. These boxes are available anywhere; the Dick Smith Electronics catalog shows it as type 'UB5', for $2.95.

On one end of the board is a PCB-mount DB-9 female connector, the smaller type commonly used for a RS-232 standard serial port. The connector body has been allowed to extend slightly beyond the end of the board. If you cut a rectangular hole of 12 x 30mm in one end of the box, the overlap can protrude through such that the 'face' of the connector is clear of the box's outside surface. This allows the connector to be plugged straight into a computer's DB-9 serial port, with the whole Pocket Packet modem effectively becoming the 'back shell' for the plug.

The arrangement is a natural for a laptop computer in a portable environment. But with a bigger computer, or one with a 25-pin serial port, you might want to make up a short cable to connect the modem to the computer. For a nine-pin connector the cable connects pin-for-pin. The connection for a 25-pin connector is shown in Table 1. Only five wires are required.

The other end of the PCB has the connections for the radio, numbered 1 through 5. If you use only one radio, be it a mobile, handheld, or scanner, you can run a cable through a hole in the end of the box and connect it directly to the pads on the PCB. But if you use more than one radio, a nice arrangement is to install a 5-pin panel mounting DIN socket in the end of the box.



Here is the PCB overlay for the Pocket Packet modem. Note that many of the resistors and diodes are mounted on end, to conserve space (see photo).

The pads on the PCB can then be wired to the corresponding pin numbers on the connector. These pin numbers follow, more or less, the pin numbers used by the 'Tiny-2' series of stand-alone TNC's. So if you happen to own one of these, you can use the same radio cable for both the TNC and the Pocket Packet modem.

In the Pocket Packet connector, pin 5 connects to resistor R12 used for PTT control in handheld radios. If you're making up a cable for a handheld you can bridge pins 3 and 5 within that cable's DIN plug (they're right next to each other). If the cable is for a conventional transceiver, the jumper is omitted and instead pin 3 is taken through to the radio's PTT line. If the radio is a Yaesu handheld, then both pins 3 and 5 are simply ignored.

Thus, the mode of radio transmitter control is selected not within the Pocket Packet modem, but within the DIN connector of that particular radio's connecting cable. Change to a different radio and cable, and the mode automatically changes. (My goodness — what a clever idea, Tom! Thank you, I thought so too...)

Now let's look at two software options currently available for the Pocket Packet modem. At this stage they are for the IBM-PC only. Both of these are shareware packages, meaning that you as the user should send a suitable fee to the people responsible for writing the programs. Please be generous; they went to a lot of work to write the software. If it wasn't for them, you would be spending hundreds, not tens of dollars, to get going on packet.

BayCom's software

Well, here's where any further references to BayCom come to a screeching halt, because the BayCom people have forbidden us to distribute their program as shareware. Pity, it is an excellent program, but as copyright owners it is certainly their right to say who distributes their program and who doesn't.

This doesn't mean you can't get BayCom though; you just can't get it from High-Tech Tasmania. The package is still freely available on most telephone computer bulletin boards that cater for 'ham radio' interests, and I've even seen it available for download on some packet radio BBS's.

At this stage we are still able to include copies of the German SP package with the Pocket Packet modem, although I understand certain forces in Australia are trying to put a stop to that too. Perhaps they are a little grumpy because we are selling modems at less than half the previous going rate.

But not to be shot down quite yet, we have come up with another software alternative which could turn out to be the best so far: a thing called 'GP'.

GP: Graphic Packet

Graphic Packet uses a GUI (graphic user interface) and puts on the 'look and feel' of a Windows application. But it is NOT a Windows application, it uses good old MS-DOS, and its reliability seems to be as solid as a rock. Readers of Moffat's Madhouse will know that I am not all that enamoured with GUI's, but this time you get all the good bits

with none of the bad bits. The only negative against Graphic Packet is that you MUST have an EGA or VGA video system — which means no CGA laptops and no XT's with Hercules monochrome. But most desktop computers these days seem to have EGA as a minimum, and the latest 'notebook' computers have VGA.

GUI implies that you must use a mouse, and followers of rodent technology will find that GP handles a mouse nicely. But non-mouse use is also catered for; each of the program's screen icons can be 'clicked upon' with a combination of the ALT and a letter key, as well as a mouse button. In my computer this is essential, because I've only got two COM ports and COM2 is taken up by an internal fax modem. So the mouse, when present, lives in COM1, but it has to be removed when I want to use Pocket Packet in COM1 — the only choice available. Bye-bye mouse! It's a horrible thing anyway.

This part of the article was written several weeks after the main part, too late for new photographs. But I'll try to describe the GP screen to you. It's the usual arrangement of a transmit window at the top, a receive window in the middle, and it appears you can have a monitor window at the bottom. I got this once, accidentally, and haven't been able to do it again. The program instructions are, as usual, in German, although English on-line messages are available.

Below the transmit window is a display showing which callsigns are connected to which channels. And below this is an overall status indicator. The default colours for this are white on purple. This sounds pretty yucky, but it looks like a lot of planning has gone into the default screen colours and the purple status bar looks quite nice in the context of the other colours.

Along the bottom of the screen is a row of eight icons to select various program functions. These are primarily for mouse clicking, but each one also has a word describing its function (in English) with one letter underlined. You can press ALT plus the letter to select that icon.

Icons change meaning, depending on the state of the program. For instance, if you have selected one of the channels, the first icon shows a picture of a plug and socket going together, with the word 'Connect'.

You can click on it, or press Alt-C to connect with a station. Once connected, the icon changes slightly to show the plug and socket being pulled apart, and the word 'Disconnect'. You can click, or use ALT-D to disconnect.

To go to the monitor mode (listeners take note!) you click an icon of a computer screen or press ALT-M. The first icon now changes to a big yellow 'H' for the MHEARD function. This will tell you what callsigns have been on air while the program has been running.

The monitor, by the way, gives you a full screen, just like with 'Brand-X' and SP. Monitor text, or any incoming text for that matter, can be scrolled up and down, either by clicking on a side-bar *a la* Windows, or by pressing Page-Up or Page-Down.

Just above the row of icons is a series of gray-coloured buttons and lights that look for all the world like they are made of metal. They also have a sculpted, 3-D effect. These indicators light up green to show when certain features are selected, for instance ECHO which makes whatever is typed on the transmit screen appear on the receive screen as well — very nice. And as a final touch, the screen displays a nice analog clock with real hands in the upper right corner of the screen.

TABLE 1:
9-pin to 25-pin RS-232 cable for pocket packet

MODEM LINE	DB-9 Male	DB-25 Female
TXD	3	2
DTR	4	20
GND	5	7
RTS	7	4
CTS	8	5

Even without English instructions, installing GP is dead easy. All you really have to do is tell it which COM port to use, plug in your callsign, and you're away.

Over the past few days I've given GP a pretty good thrashing on my AT-clone computer and it hasn't indulged in any funny business at all. I hate to admit it, but quality programs like Graphic Packet could eventually sell me on GUI's. Providing I don't have to use that blasted mouse, of course...

According to a document file describing the GP package, 'The programs may be used and distributed without any registration fees'. So, in theory at least, we should be able to include courtesy copies of GP on the Pocket Packet disks. You should, in theory, be able to use it without cost, but it would be nice to send an appropriate donation to the author anyhow.

The SP software

'SP' came to us down a telephone line, direct from a university in Germany. From what I can determine SP is totally unknown in Australia. When I tell some connect-partner I'm using SP, they always say 'What!?'. We don't even know what SP stands for — Super-Packet? Silly-Packet? Siegfreid's Packet?

SP looks and acts very much like BayCom, with the same three windows and two status lines. Operation is similar, except that SP uses a lot of ALT-key combinations such as ALT-C to connect, instead of the typed command 'CONNECT' as with BayCom.

SP isn't so easy to get going, mostly because of a lack of English instructions. In fact the version we got didn't have a proper German instruction file either — just a file called 'RELEASE.NOT' which appeared to contain brief instructions in German. But there are comprehensive on-line HELP facilities in English, along with an English list of (brief) command descriptions.

If you are an experienced packet user, you'll find SP a breeze; if you're new to packet you'll find SP an adventure. But in the end you may learn *more* from SP, because you have to figure out so much of it for yourself. I must admit, as an inexperienced packet user, that I got immense satisfaction out of getting SP to work in the first place. It was like busting a big crossword puzzle. And there is more satisfaction as each new trick is revealed.

SP has the potential to be a much more advanced program than BayCom as it stands. For instance it appears possible to 'teach' SP the correct paths through various digipeaters, for stations you frequently connect with. So you can call up a menu and select the station's callsign, and SP does the rest.

SP again comes in two parts: the SP terminal program itself, and a thing called 'TFPCX' from a different author. This is the 'software TNC' part, like BayCom's 'L2'. For experimenters and 'hackers' the package includes the complete C-language source code for SP, so if you don't like the way it works you can change it. Comments within the source code are in English, and there are plenty of them.

One English message within the SP documentation says 'Free for radio amateur' and there is no suggestion that a donation would be appropriate, at least not in English. But users of the program should still make an effort to reward the authors in some way as a show of support.

BayCom 1.4e will be the 'default' package to fill out our Pocket Packet software disk, but we will substitute SP on request. In the event you want both BayCom and SP, we can supply a separate disk with SP, TFPCX, all available source code, and some quick notes from me on how to get it running, for a nominal fee of $10. This only covers our expenses for the disk and copying — it is not a 'sale' of the software.

Getting the kit

The Pocket Packet kit is available only by mail order from High-Tech Tasmania, 39 Pillinger Drive, Fern Tree, Tasmania 7054. The cost is $79.00, posted within Australia or New Zealand. It is possible the price may change in the future, because so much of the kit price involves the imported TCM-3105 modem chip. Orders must include a money order or cheque in *Australian dollars*. We cannot accept phone orders, although anyone with questions about Pocket Packet can ring us on (002) 39-1391.

The kit includes the PCB, all parts including the TCM-3105, and the nine-pin serial connector for the computer. The kit does NOT include the plastic box, because it would then have to be posted as a 'parcel' instead of a 'large letter'. This is more expensive and much slower. You must also supply whatever cables and connectors are required to hook the Pocket Packet modem to YOUR radio. Every model is different.

Also included is a disk (please state size) containing full assembly instructions and a pair of computer programs needed to test and align the modem's transmit and receive functions and the watchdog timer. The balance of the disk will be filled out with a courtesy copy of Graphic Packet, or alternatively with the SP package and TFPCX. Bear in mind that we cannot guarantee that either of the programs will be included, since we do not own them.

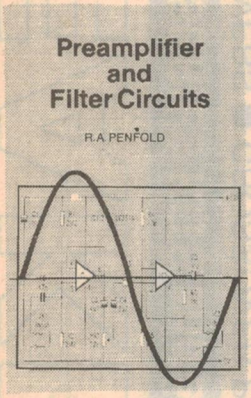
By the time you read this, both GP and SP should be available on computer bulletin boards throughout Australia. And that 'other program' will probably be there as well, should you wish to download it.

Many people have contacted me asking if Pocket Packet can be used on the Amiga. I have been searching bulletin boards all over the world, but so far I have been unable to find any software package that uses a software TNC. Should anyone know of such a thing, please let me know and perhaps we can produce an Amiga Pocket Packet. The modem itself should work fine, given the correct software. ❖

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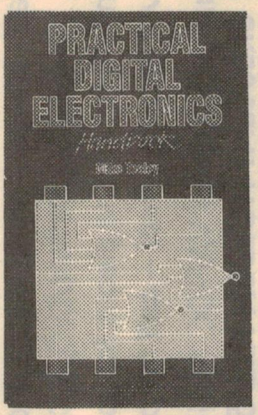
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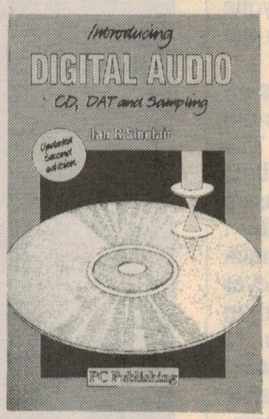
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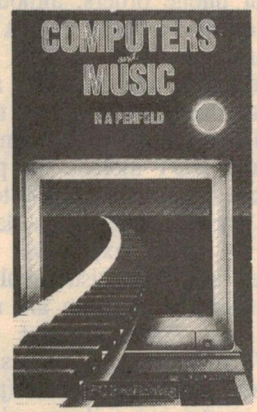
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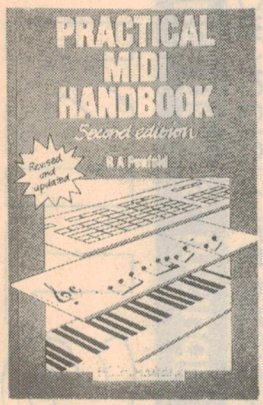
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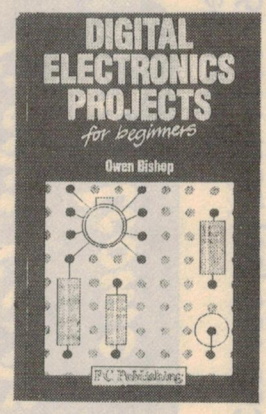
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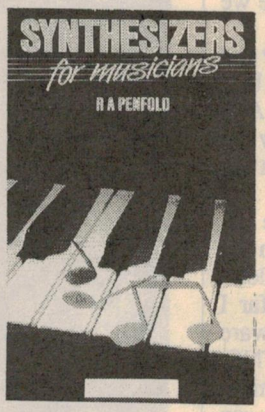
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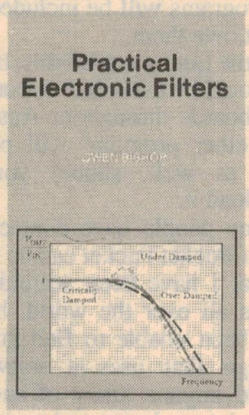
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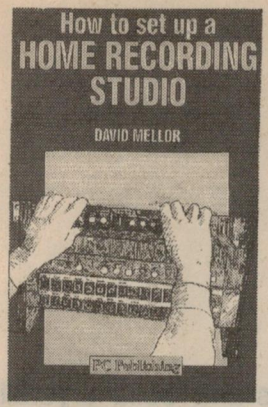
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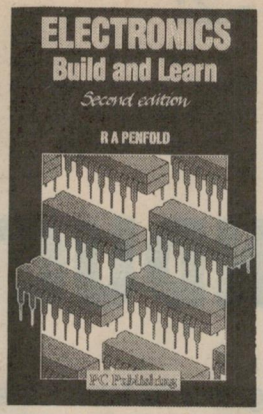
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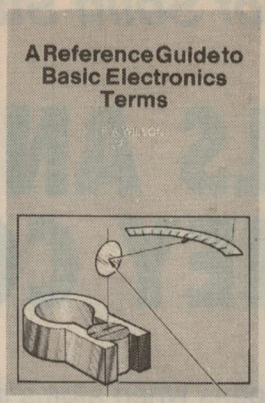
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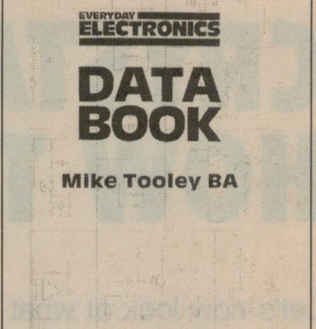
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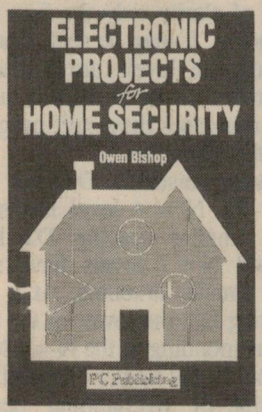
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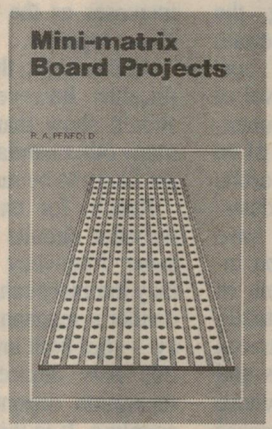
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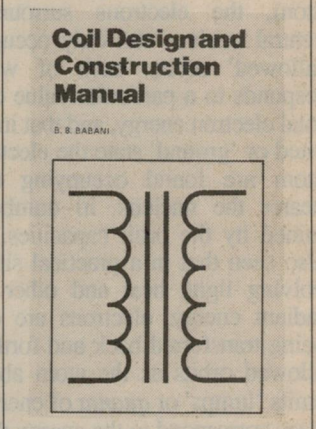
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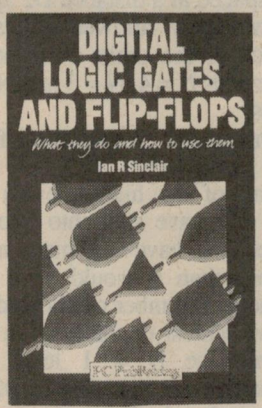
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Fundamentals of Solid State - 2:

CRYSTALS AND HOW THEY CONDUCT

Let's now look at what happens when atoms link together to form molecules and 'solid' crystalline matter. We'll examine the formation of electron energy bands, and how these play a role in electrical conduction. And in particular, we'll look at crystals of semiconductor material, and the way conduction in these can be via either electrons or 'holes'.

by JIM ROWE

We have seen that in an individual atom, the electrons surrounding the central nucleus can only occupy certain 'allowed' orbits, each of which corresponds to a particular value or level of total electron energy, and that in the unexcited or 'ground' state the electrons of an atom are found occupying the orbits nearer the nucleus, in numbers determined by the orbit capacities. We have also seen that in a practical situation involving light, heat and other forms of radiant energy, electrons are constantly being transferred back and forth between allowed orbits as the atom absorbs and emits 'lumps' or *quanta* of energy, whose sizes correspond to the energy differences between the various levels.

Now two individual and separate atoms of the same element will possess the same allowed orbit structure, or in other words, the energy levels of their allowed orbits will be identical. Note that in saying this, we make no reference to the electrons occupying the levels, but refer only to the allowed levels themselves.

Hence it is not implied that at every instant of time each atom will have exactly the same excitation energy, with identical numbers of electrons at each level. In fact, this would not be so even if their situations were equivalent, because the random nature of energy absorption and emission would produce instantaneous differences — so that all we could say is that they had the same *average* excitation energy.

A very interesting thing happens if two such atoms are brought near to one another: the electric fields around the two nuclei interact, in such a way that each of the allowed electron energy levels of *both* atoms progressively 'splits' into a *pair* of levels (orbits), whose energy difference increases as the two atoms are brought closer together.

At first sight, this may seem quite inexplicable: however a moment's thought should show that it is no more so than many other similar effects with which you are likely to be familiar.

Recall, for example, that when two resonant circuits tuned separately to the same frequency are coupled together, they interact such that in the coupled state neither is resonant at the original frequency — but both are effectively resonant at two new adjacent frequencies, whose separation depends upon the degree of coupling. It is this effect which produces the familiar 'double humping' associated with large coupling factors.

Another example occurs in the case of loudspeakers fitted into tuned enclosures. Here a loudspeaker cone system and an enclosure, having the same resonant frequency when separated, interact when together to produce the same sort of double resonance — which in this case is used to smooth and extend the low-frequency behaviour.

Highest levels first

As one might expect, it is the highest or 'least negative' electron energy levels of two atoms which first split as they are brought nearer, because these correspond to the largest allowed orbits. For the same reason it will be the level pairs produced by these levels which will be found most widely separated, for any given distance or spacing between the two atomic nuclei. This is illustrated in Fig.2.1, which shows the splitting of the various energy levels as a function of the nucleus spacing.

Note particularly that this diagram applies equally to either atom, and that in the interests of clarity only the first four levels are shown. It may be seen that for large spacing, the levels are unaltered from their 'individual atom' values, but as the spacing decreases they split progressively from the higher levels.

At a spacing distance D1, for example, only the N = 4 level has split, while at a smaller spacing D2 both the N = 3 and N = 2 levels have split also, but by smaller amounts. At a still smaller spacing D3, the lower of the pair of levels corresponding to the N = 4 level has moved below the higher of the N = 3 pair. This kind of 'overlapping' occurs more and more as the spacing is reduced.

What does this mean? Simply that when two similar atoms are placed relatively near one another, their interaction effectively alters and *increases* the number of 'allowed' orbits for the electrons surrounding each. Hence when the atoms whose behaviour is represented by Fig.2.1 are spaced at a distance D2 apart, each has two new allowed orbits in place of each of the orbits corresponding to its previous N = 4, N = 3 and N = 2 energy levels.

As splitting occurs progressively from the highest levels down, this will also mean that all of the higher levels not shown will also have split into two, so that each atom will have very many more allowed orbits than it would have had alone. (In fact the number of allowed orbits will have almost doubled, as in this example only the N = 1 level has remained unaltered at a spacing of D2.)

It so happens that, in the same way that the energy levels of *two* atoms split into pairs when they are brought together, the energy levels of *larger* numbers of rela-

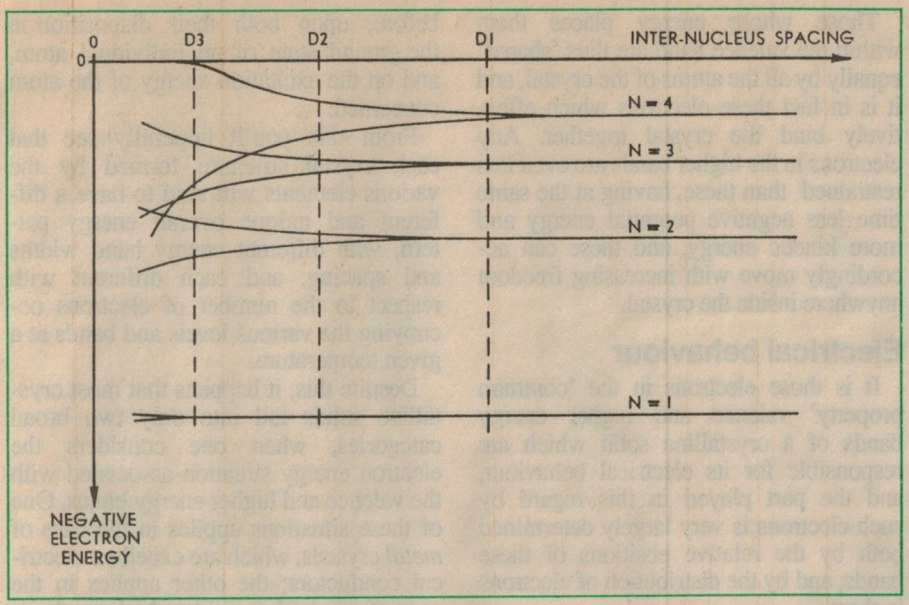


Fig.2.1: When atoms of a particular material are brought relatively close together, the energy levels gradually 'split' into pairs — beginning with the higher energy levels and working downwards.

tively close atoms are found to split into a corresponding number of new levels. With three atoms, the levels each tend to split into triplets; with four atoms, into quadruplets, and so on.

Accordingly, if we have a lump of an element comprising a large number 'M' of atoms regularly spaced at a particular distance, certain of the 'individual' energy levels will be found to have split into the same large number of M new energy levels, forming **bands.** The number of levels which will have split into such bands, and the energy width of the bands, will depend upon the atomic spacing, with the higher levels splitting before the lower ones and to a greater extend.

An example may help in picturing this situation. A cube of metal measuring one centimetre on each side typically consists of something like 10^{23} atoms — one-hundred-thousand-million-million-million. This means that in place of certain of the higher energy levels of an individual isolated atom of the metal concerned, each of the atoms of the metal cube will have bands each containing no less than 10^{23} extremely closely spaced individual levels. A cube one-hundred-thousand times smaller in volume will similarly have 10^{18} levels in each of the atomic bands — still a very large number!

In both cases, the number of bands present, and their 'width' in terms of energy levels, will depend as before only upon the inter-atomic spacing. In fact the number of bands and their width is exactly the same as the number of 'paired' levels and the separation widths produced for the simple case of only two atoms, illustrated in Fig.2.1. Hence, although the size of a lump of material determines the number of discrete levels making up each of the energy bands, it does not affect either the number or the width of the bands.

The type of atomic interaction which we have been considering occurs almost only in the 'solid' state of matter, as opposed to the 'liquid' and 'gaseous' states, because it is only in the solid state that the spacing between atoms is sufficiently small and relatively fixed. And as one might expect, the solid materials whose behaviour most closely conforms to this picture are those in which the atoms are arranged in very regular three dimensional 'lattice' patterns — the **crystalline solids.**

The electron energy relationships inside a typical crystal structure are illustrated in Fig.2.2, which is a two dimensional energy/distance representation of the same type as that for a single atom given previously in Fig.1.3.

It may be noted that in this example the *lattice spacing* or distance between the atomic nuclei is such that the N = 1 and N = 2 energy levels have remained unaltered, while the N = 3 and higher levels have split into the expected bands — each comprising M closely spaced new levels. In fact overlapping of the N = 5 and higher bands has produced virtually a single 'higher band', extending right up to the zero energy level. Such overlapping tends to occur with the higher levels in crystalline solids, both because the splitting is greater for these levels, and also because as we have seen previously the energy differences between the original atomic orbit levels decrease with increasing distance from the nucleus.

In this example the N = 3 band is shown as the **valence band,** which corresponds to the valence electron energy level of the individual atoms concerned. Although shown here as an isolated band, not overlapped by higher bands, the valence band is not necessarily so isolated, and is in fact overlapped in certain crystals.

As a result of the interactions between the atoms of the crystal lattice, only the walls of the electron energy wells (dashed lines) surrounding the nuclei at the *edge* of the crystal rise fully to the zero energy level, as they do with an isolated atom.

For the nuclei *inside* the crystal, the well 'walls' fuse and cancel at a somewhat lower level, as shown. The level at which they fuse is in fact very close to the

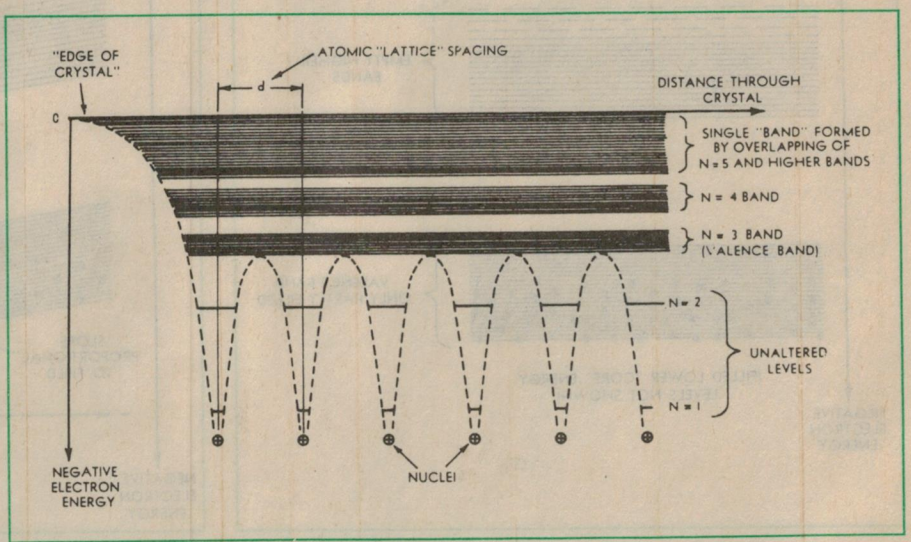


Fig.2.2: When many atoms are fixed in a crystal 'lattice' structure, the upper energy levels split into so many levels that they form bands. Electrons in these bands are effectively 'owned' by all of the atoms in the crystal.

valence band, and this has considerable importance. It may be noted that *below* the fusion level, the original electron energy levels are unaltered, and that they are shown as before separately for each nucleus. Conversely *above* the fusion level, all levels have become bands, and are shown extending continuously throughout the lattice.

The significance of these distinctions is that electrons occupying energy levels *below* the fusion level are still influenced almost solely by the individual atomic nuclei, whereas electrons occupying the energy bands *above* the fusion level are virtually uninfluenced by single individual nuclei, and are effectively 'common property'.

In other words, this means firstly that electrons having low or more negative energy can exist in the crystal lattice only in orbits closely surrounding the individual nuclei.

These are the highly bound 'core electrons', and they will be those occupying orbits corresponding to the unaltered energy levels represented in Fig.2.2, by the N = 1 and N = 2 levels.

On the other hand, electrons having higher or less negative energy can occupy any of the many levels comprising the valence and higher bands, in which they are no longer the 'property' of individul atoms but belong only to the crystal as a whole.

Those whose energy places them within the valence band are thus 'shared' equally by all the atoms of the crystal, and it is in fact these electrons which effectively bind the crystal together. Any electrons in the higher bands are even less restrained than these, having at the same time less negative potential energy and more kinetic energy, and these can accordingly move with increasing freedom anywhere inside the crystal.

Electrical behaviour

It is those electrons in the 'common property' valence and higher energy bands of a crystalline solid which are responsible for its electrical behaviour, and the part played in this regard by such electrons is very largely determined both by the relative positions of these bands, and by the distribution of electrons in them.

Hence in order to gain an insight into electrical conduction in a crystal, we must look more closely at both the bands themselves and the ways in which electrons can occupy them.

There are a number of different ways in which atoms can link or 'bind' together to form crystal structures. Depending upon the type of atomic bond involved, and the size of the atoms, a particular crystal lattice will have a definite inter-atomic spacing, and thus an appropriate number of the atomic electron energy levels will be split into bands of appropriate width.

The disposition of electrons in the allowed levels and bands will depend, as before, upon both their disposition in the ground state of an individual atom, and on the excitation energy of the atom concerned.

From this you'll hopefully see that each crystal structure formed by the various elements will tend to have a different and unique overall energy pattern, with different energy band widths and spacing, and each different with respect to the number of electrons occupying the various levels and bands at a given temperature.

Despite this, it happens that most crystalline solids fall into only two broad categories, when one considers the electron energy situation associated with the valence and higher energy bands. One of these situations applies in the case of *metal* crystals, which are excellent electrical conductors; the other applies in the case of crystalline solids which are basically either *semiconductors* or *insulators*.

The first type of situation is basically that in which the valence electrons of the various atoms of the crystal do not completely fill the valence band in the ground state, as illustrated in Fig.2.3.

This situation can arise if the electrons of an individual atom of the element concerned do not fill the original valence level; it can equally be caused by a crystal lattice spacing which results in overlapping of the 'true' valence band by a higher order band or bands, to produce a much wider effective valence band. For our purposes, it does not matter which factor is responsible, the essential point being that

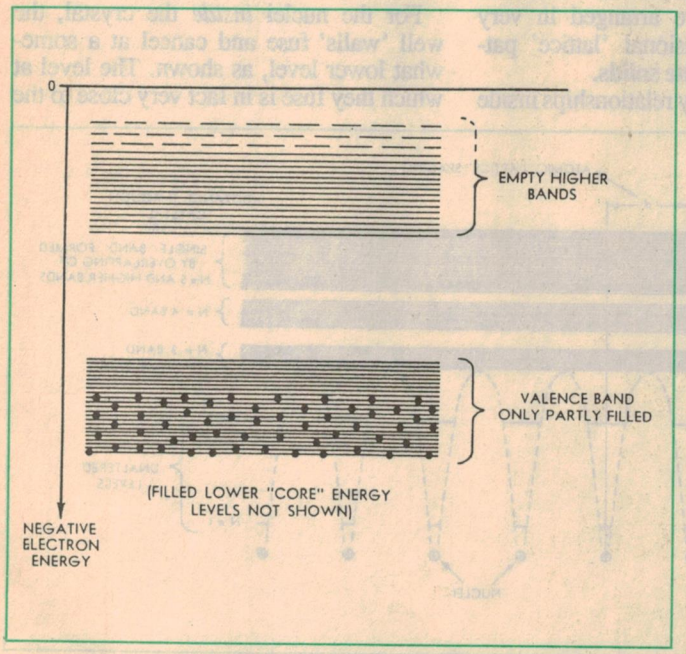


Fig.2.3: In a crystal of conductor material, the valence band is only partly filled with electrons, even in the unexcited or 'ground' state.

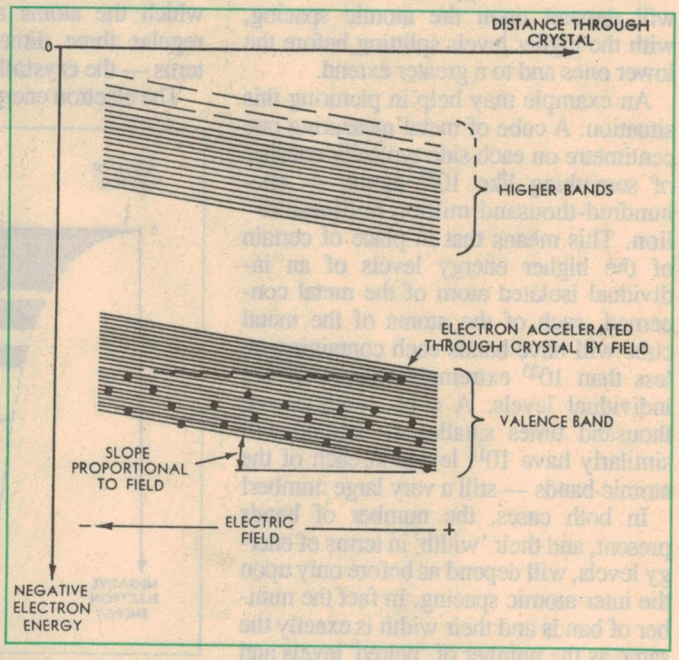


Fig.2.4: When an electric field is applied to such a crystal, electrons are very easily accelerated by the field because of the unoccupied levels in the valence band.

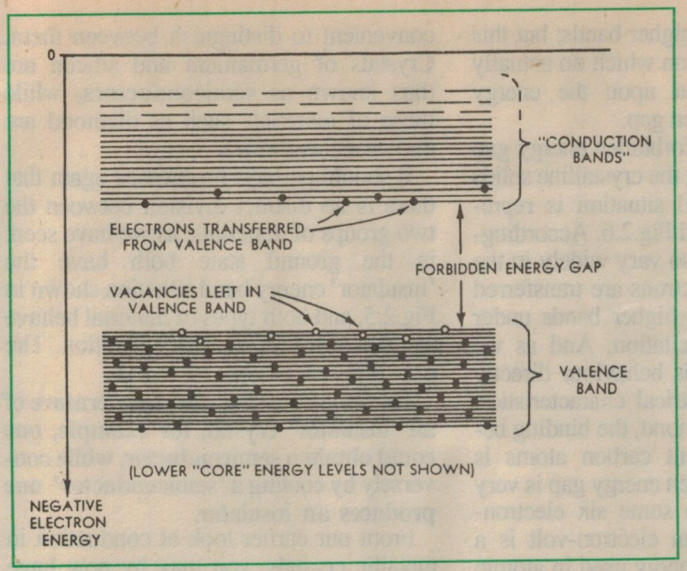


Fig.2.5: In a crystal of insulator or semiconductor material, the valence band is completely filled with electrons when the crystal is in the ground state.

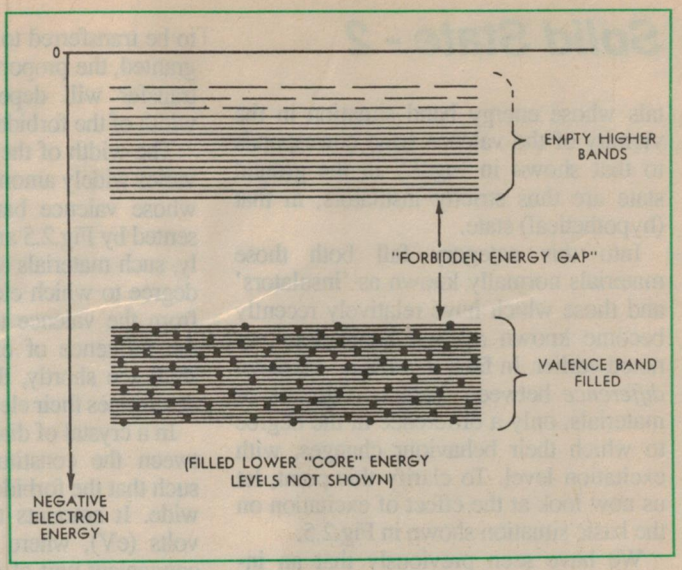


Fig.2.6: When such a crystal becomes excited however, thermal energy can transfer electrons from the filled valence band into the initially empty conduction bands.

the valence band ends up not completely filled.

In order to understand how this situation allows the crystal concerned to act as a good electrical conductor, consider for a moment what happens when an external source of EMF (voltage) is connected across the crystal.

Due to the applied EMF, an electric field is set up through the crystal; as a result one end of the lattice has an effective potential energy with respect to the other — so that the various electron energy levels and bands no longer remain horizontal, but have a slope which corresponds to the electric field gradient. This is illustrated in Fig.2.4, which shows the same valence and higher energy bands which were shown in equilibrium in Fig.2.3

Electrons are always in motion, and those in the valence band of a crystal are continually 'sharing themselves around' among all the atoms of the lattice. The effect of the applied electric field, as you might expect, is to produce a tendency for the electrons to be accelerated in the 'downhill' direction of the field, and slowed down or decelerated in the 'uphill' direction.

Now deceleration of electrons by the field is in fact difficult, because this implies loss in kinetic energy, and falling of the electrons concerned to lower levels; yet the lower levels are filled.

However, the converse process of electron acceleration is quite easy, because this involves the transfer of electrons to higher energy levels, and such levels are in this case readily available — in the form of the remaining empty upper levels of the partly-filled valence band. Acceleration of electrons thus occurs readily under the influence of the field, and there is the 'nett flow of charge from one end of the crystal to the other' which we define as an **electric current.**

In moving through the crystal the electrons exchange negative potential energy for kinetic energy, jumping from level to level and effectively moving along the crystal energy diagram along paths such as that shown in Fig.2.4.

A solid material can therefore be defined as an electrical **conductor** if its energy band situation in the vicinity of the valence band corresponds to that shown in Fig.2.3. In other words, it is one in which the valence band is only partly filled with electrons. This is the situation which applies in the case of metallic conductors such as copper, gold, silver and aluminium.

Valence band filled

The second type of energy band situation which can occur in the vicinity of the valence band of crystals in the ground state is that illustrated in Fig.2.5. It may be seen that the only essential difference between this situation and that for a good conductor shown in Fig.2.3, is that the valence band is here **completely filled.** The only energy levels of the crystal unoccupied in the ground state are thus those in t he higher bands, separated from those of the valence band by a relatively wide *forbidden energy gap.*

It may seem surprising, but a crystalline solid in which this energy band situation occurs is completely unable to conduct electricity when in the ground state. This is because a nett electron flow from one region of the crystal to another is impossible in any energy level which is completely filled with electrons, and in this case all the levels of the valence band are so filled.

The reason why a nett electron flow cannot occur in a completely filled energy level is that, for a nett flow to occur, there must be set up either an electron density or an electron velocity unbalance between one 'end' of the level and the other. In a completely filled level a density unbalance is fairly obviously impossible; but so too is a velocity unbalance, because by definition all electrons in a given level have the same kinetic energy.

It may help in understanding this point if one imagines a filled level as something like a highway capable of carrying only a single lane of cars in each direction, and on which all the cars must travel at a fixed speed (corresponding to the particular energy level). If the highway is 'filled' with both lanes carrying cars moving 'bumper to bumper', there is no way in which more cars can travel in one direction than in the other; in other words, there can be no 'nett car flow' in either direction.

The only ways in which a nett flow could occur would be either if the lanes of the highway were not filled, so that more cars could conceivably travel in one direction than in the other (a density unbalance), or if cars could travel at different speeds (a velocity unbalance) — the latter implying the availability of additional 'energy level' lanes.

From the foregoing it may be seen that if the valence band of a crystalline solid is completely filled, the crystal concerned will be an electrical **insulator.** ALL crys-

tals whose energy band situation in the vicinity of the valence band corresponds to that shown in Fig.2.5 in the ground state are thus strictly insulators, in that (hypothetical) state.

Into this category fall both those materials normally known as 'insulators' and those which have relatively recently become known as 'semiconductors', as noted earlier. In fact, there is *no essential difference* between these two groups of materials, only a difference in the degree to which their behaviour changes, with excitation level. To clarify this point, let us now look at the effect of excitation on the basic situation shown in Fig.2.5.

We have seen previously that an individual atom would only be in its ground state if it could be maintained at a temperature of absolute zero (-273°C), shielded against all forms of radiant energy such as heat and light; whereas in actual fact, an atom in a practical environment is taking part in a continual process of energy absorption and emission, involving the transfer of electrons between its various allowed energy levels. As you might expect, the same argument applies to a crystal lattice composed of a large number of such atoms.

A crystalline solid in a practical environment involving heat, light and other radiant energy is therefore similarly involved in a continuous process of absorption and emission, with electrons now transferring both between levels within the crystalline energy bands, and also between the bands.

The latter naturally involves transfer across the relatively large forbidden energy gaps between bands.

Under such conditions the 'insulator' energy band situation shown in Fig.2.5 will change. Absorption and emission of energy by the crystal lattice will reach a dynamic balance or equilibrium at an excitation level above the ground state, in which a small proportion of ever-changing electrons from the valence band have been transferred to higher energy bands. This is illustrated in Fig.2.6.

The extent to which this will occur depends both upon the energy level of the environment in which the crystal finds itself, and also upon the width of the forbidden energy gap between the valence and next higher energy band.

Naturally enough, the higher the temperature of the heat energy present in the crystal (the 'bluer' the light incident on its surface, and so on), the greater will be the tendency of valence band electrons to acquire the energy necessary for them to be transferred to higher bands; but this granted, the proportion which do actually transfer will depend upon the energy width of the forbidden gap.

The width of the forbidden energy gap varies widely among the crystalline solids whose valence band situation is represented by Fig.2.5 and Fig.2.6. Accordingly, such materials also vary widely in the degree to which electrons are transferred from the valence to higher bands under the influence of excitation. And as we shall see shortly, this behaviour directly determines their electrical characteristics.

In a crystal of diamond, the binding between the constituent carbon atoms is such that the forbidden energy gap is very wide. It amounts to some six electron-volts (eV), where an electron-volt is a convenient unit of energy used in atomic physics and other fields; one electron volt is the potential energy acquired by an electron when it is moved through an electric field for a distance corresponding to an increase of one volt.

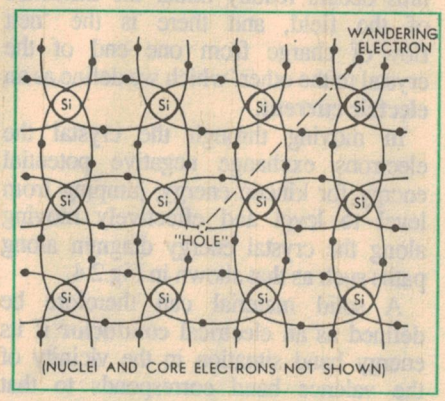


Fig.2.7: When thermal energy frees an electron from a valence bond, making it available for conduction, a positive 'hole' is also created — and this is also able to contribute towards conduction.

In comparison, the forbidden energy gap of pure germanium crystal is only 0.72eV, while that of pure silicon is only a little larger at 1.11eV.

It may be seen from this that in such materials the proportion of electrons which have transferred from the valence band to higher bands will be much greater, at a given degree of excitation, than for a material such as diamond.

Because under 'normal' practical conditions crystals of materials like germanium and silicon *do* have significant numbers of electrons which have transferred from the valence band to higher bands, whereas crystals of materials like diamond have not, and because this results in significant differences in the normal-conditions electrical behaviour of the two groups of materials, it has become convenient to distinguish between them. Crystals of germanium and silicon are thus known as **semiconductors,** while those of materials such as diamond are known as **insulators.**

It should perhaps be stressed again that there is no distinct division between the two groups of materials; as we have seen, in the ground state both have the 'insulator' energy band situation shown in Fig.2.5, and both types of material behave as shown in Fig.2.6 with excitation. The only difference is one of degree.

Hence by raising the temperature of an 'insulator' crystal, for example, one could obtain a semiconductor, while conversely by cooling a 'semiconductor' one produces an insulator.

From our earlier look at conduction in metallic crystals, you may by now have deduced that a semiconductor crystal in the excited state shown in Fig.2.6 will become quite a good conductor, by virtue of the electrons which have transferred from the originally full valence band into the originally empty higher bands. And this is quite so, although it is only half the story.

The electrons which have transferred into the higher bands, because these bands are largely empty, are certainly capable of forming a nett carrier flow through the crystal under the influence of an applied electric field. In fact because of this, the higher bands are usually called the **conduction bands,** as shown in Fig.2.6. However, as it happens, the 'vacancies' which are left by these transferred electrons back in the valence band are *also* able to contribute to conduction.

In order to understand this, consider that when an electron is transferred from the valence band to a conduction band, this is actually equivalent to the weakening of a valence electron bond between two adjacent nuclei of the crystal lattice.

Instead of the usual two-electron 'covalent' band, which each nucleus shares with each of its four adjacent nuclei, there is left in the place concerned a 'weakened' bond having only a single electron. This is illustrated in the two-dimensional picture of Fig.2.7, where the weakened bond is shown consisting of the single remaining electron together with a **hole** or vacancy, in place of the missing electron.

Because of the missing valence electron, the electrical charge balance of the crystal lattice is upset in the vicinity of the weakened bond. The positive charges of the relatively fixed atomic nuclei are no longer exactly balanced by the negative charges of the surrounding electron population, so that a localised *nett positive charge* is produced.

In fact this positive charge is localised right in the 'hole' originally occupied by the missing electron, and it has a value of charge equal and opposite to the negative charge of an electron. Neither of these facts is really surprising, in view of the way in which the charge is produced.

The interesting thing is that such a hole is capable of moving through the crystal lattice, and as a moving positive charge it can thus effectively make a contribution to a current flow which is almost equal (but opposite) to that of an electron.

A hole tends to move through the crystal lattice because electrons in neighbouring valence bonds are attracted by its positive charge; when such an adjacent electron jumps across to 'fill' the hole, it in turn leaves a hole in its own original bond to be filled by another electron, and so on. This 'leapfrog' effect results in the effective movement of the hole through the lattice. Under the influence of an applied electric field, the hole movement will tend to take place in the direction *opposite* to that taken by a conduction band electron.

It may perhaps seem from this description that the concept of a hole is a redundant one, for the reason that 'hole movement' in a particular direction through a crystal might seem to be 'really nothing more' than a series of small jumps by electrons in the opposite direction; but this is not so.

The fact is that the localised positive charge present in a crystal lattice at a weakened valence bond is no more and no less a reality than the 'localised negative charge' which we are pleased to call an electron. It even has an effective mass, which is approximately equal to that of an electron.

To use an analogy, a hole in a crystal lattice valence band is rather like an air bubble in a test-tube almost filled with water. Both might be interpreted merely as 'vacancies' whose effective movement takes place purely by means of movement in the opposite direction of something which superficially seems more 'real'— like electrons, or water. Yet like the air bubble, a hole makes its existence apparent by means of its behaviour, in this case its electrical behaviour.

In a semiconductor crystal of the type whose valence band situation is shown in Fig.2.5 and Fig.2.6, then, for every electron which is transferred to the conduction bands and accordingly becomes available as a 'negative current carrier', there is also produced a hole **which remains in the valence band** but is equally available as a 'positive current carrier'.

Because of this, it is usual to say that excitation of a semiconductor crystal lattice results in the production of **electron-hole carrier pairs.** Similarly the emission of energy by the lattice is visualised as a process whereby a wandering electron in the conduction band 'accidentally' meets a hole wandering the valence band, the two permanently cancelling or 'annihilating' one another and producing a photo of appropriate energy. The latter process is usually termed **recombination.**

A pure or **intrinsic** semiconductor material such as we have been considering thus contains, in the excited state, equal numbers of conduction band electrons and valence band holes available for electrical conduction.

However the two types of carrier do not contribute to current flow in an exactly equal manner, because holes are in the valence band and cannot move through the material at the same rate as conduction band electrons.

Table 1

Material	Resistivity, Ohm-cm
Copper	1×10^{-6}
Silver	1.62×10^{-6}
Gold	2.44×10^{-6}
Germanium	47
Silicon	214,000
Mica	1×10^{16}
Diamond*	3×10^{42}

***Theoretical resistivity. In fact unmeasurable.**

In effect, whereas the electrons in the conduction band can move speedily through the lattice without having to conform to any orbit requirements, the holes in the valence band must 'weave' their way through the crystal binding orbit system, and therefore travel at a slower rate.

Holes are therefore said to have a lower **mobility** than electrons, as current carriers.

This means that while the *numbers* of free electrons and holes present in an excited intrinsic semiconductor at any one time are equal, any nett current flowing through the material is carried more by the faster-moving conduction band electrons, moving from negative to positive, than by the slower-moving holes moving from positive to negative.

To use the analogy of a highway introduced earlier, but in a slightly different sense, the situation is now like a two-lane highway in which both lanes are packed with cars travelling in opposite directions, bumper to bumper — but in this case at different speeds (corresponding to the two different energy bands). Although any given length of highway will contain equal numbers of cars in the two lanes, there will still be a greater car 'flow' in the faster lane than in the slower lane.

Because the generation of electron-hole carrier pairs depends upon the excitation level of the crystal lattice, the number of such carriers available for conduction varies directly with the excitation level. Hence the **conductivity** of an intrinsic semiconductor crystal similarly varies directly with excitation. In the ground state, as we have seen, it will be zero: in more practical circumstances, it will rise to a value which will depend directly upon both the temperature and the frequency/intensity characteristics of any light (or heat) incident at its surface.

At this point, it is perhaps worthwhile to pause briefly and note the contrast between the current picture of semiconductor-insulator conduction, which we have been examining, and earlier ones which held that these materials were merely those wherein the valence electrons were 'harder for the electric field to pull free'.

You can hopefully see now that the latter idea was quite wrong, because in fact such materials *cannot conduct at all* under the influence of an electric field alone; they become capable of conduction *only* when excited. Neither this fact, nor the existence of holes as additional current carriers in these materials, could be explained by the earlier theories.

In talking about the electrical behaviour of a semiconductor at a particular excitation level, reference is often made to the **resistivity,** which is simply the reciprocal of the conductivity. Resistivity is usually defined as the resistance in ohms between opposite faces of a cube of material measuring one centimetre on each side; this gives units of ohms/cm/square cm, or **ohm-cm.**

As the conductivity of an intrinsic semiconductor rises from zero with excitation, this means that the resistivity effectively falls from a value of infinity. Table 2.1 gives the approximate resistivity figures for pure silicon and germanium under 'normal' conditions, and also gives the equivalent figures for typical metallic conductors and insulators, for comparison.

The fact that the resistivity of intrinsic semiconductors falls sharply with excitation is exploited by using them in thermistors, or temperature-dependent resistors, which have a negative coefficient.

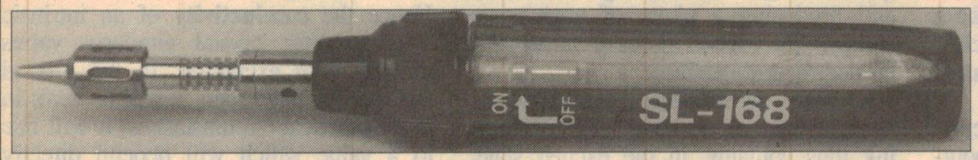
This is in fact the main use of intrinsic semiconductors as such, their resistivity being rather too high and too temperature-dependent for direct use in most other semiconductor devices. ❖

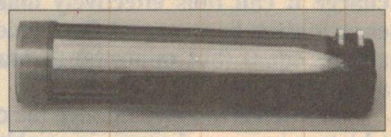
JAYCAR SPECIALS FOR JANUARY

HOT-SOL GAS SOLDERING IRONS

NEW FROM JAYCAR

DISTRIBUTORS WANTED





Cap shown in reduced size

Jaycar Electronics proudly announce a new force in Gas Soldering Irons.

The Hot-Sol needs no cords or gas bottles. All you need is standard Butane cigarette lighter gas which is available everywhere. The Hot-Sol has adjustable temperature control, you can vary it from the equivalent of 10 to 60 watts.

Features include

• Totally see through case - see how much gas you have left at a glance. • Supplied with protective cap with pocket clip. • Built-in gas ignition. • Fully portable, always ready to use. • Heavy duty, tip temperature up to 400°C. • Hard working, one fill will last an hour. • Refills in seconds. • No leakage current to sensitive circuits. • Low cost. • Spare tips available, and they are not expensive. • Hot blow tip available. • Supplied with 2.4mm tip. • 1 y

HOT-SOL GAS SOLDERING IRON

Cat. TS-1700

ONLY $38.95

HOT-SOL SERVICE KIT

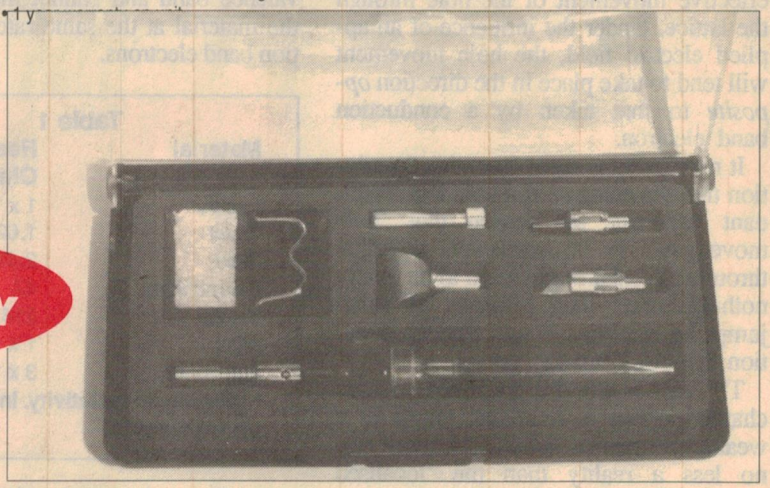
This kit includes the same soldering iron, but comes with a range of accessories and it's all housed in its own case.

Includes:

1 x Hot-Sol Butane Gas Tool
1 x Protective cap and pocket clip
1 x Non slip stand with sponge
1 x Torch tip wich gives a flame
1 x 2.4mm soldering tip
1 x Hot blow tip for shrinking heatshrink tubing
1 x Scoop for feeding tubing to hot blow tip
1 x Hot knife tip
1 x Roll solder
1 x Case which holds everything

1 YEAR WARRANTY

NEW FROM JAYCAR



Cat. TS-1702

ONLY $64.95

OPTIONAL EXTRAS

● 1mm soldering tip with catalyst Cat. TS-1704 **$9.95** ● 2.4mm soldering tip with catalyst Cat. TS-1705 **$9.95** ● Hot air tip for heatshrink Cat. TS-1708 **$9.95** ● Flame torch tip Cat. TS-1710 **$3.95** ● Small stand to suit soldering iron Cat. TS-1720 **$3.95**

LOW COST MAINS PROTECTION FOR COMPUTERS, MONITORS, PRINTERS, FAX'S, PHOTOCOPIERS, ETC.

IEC IN-LINE MAINS FILTER

The Jaycar MS4000 will provide a quick, low cost means of SURGE and SPIKE protection for computers, monitors, printers, fax's, photocopiers, plus a wide range of other micro processor products. It consists of a lead with IEC plug to 240V plug, two metres long with the mains filter in-line.

Technical Specifications

Lead	240V plug to IEC plug
Cable	2 metres long
Material	Flame retardant ABS case
Voltage	240V 50Hz
Max Current	10A 2300 watts
Total Energy Rating	40 Joule 8/20µS
Filtering	Surges, spikes
Clamping	275V rms
Peak Energy Diverter	2,500 amps
Protection Type	PN, PE, NE
Approved	Aust Safety Standards AS3100, AS3105

Cat. MS-4000

ONLY $27.95



NEW FROM JAYCAR

TWO OUTLET IN-LINE MAINS FILTER

This is the big brother to the MS4000. The MS4002 features a large 4.5kA, 120 Joule 8/20µS transient protection. The unit consists of an IEC mains lead with a box mounted in-line. Also included in this box is a 2nd 3 pin outlet, so two pieces of equipment can be protected easily. The MS4002 brings together a number of benefits to the computer user. Transients can be caused by other localised equipment such as printers and peripherals as well as on the main power supply, and air borne interference, in an effort to remove all possible sources of transients and provide protection as close as possible to the equipment. The MS4002 combines the existing mains power lead of your computer with a high grade power filter. It also incorporates one extra output receptacle to conviently connect printers or other peripherals to the same protection circuit.

Power disturbances can appear on your computers as read/write errors, memory loss component damage, programme errors, system failures and costly reboots. With the MS4002 fitted to your computer system you can • reduce service calls by up to 95% • Increase hardware life • reduce maintenance costs • reduce down time.

Technical Specifications

Voltage	240V AC 50Hz
Max Current	10A 2400 watts
Input	3 pin 240V plug
Output -2	1 x 3 pin 240V, 1 x IEC
Inrush	10 times the continuous rating
Earth Leakage	0.6mA
Efficiency	95% at full load
Duty Cycle	Continuous
Transient Response	<25A5
Energy Absorption	120J 8/20µS
Peak Clamping	275V rms
Peak Surge	4.5kA
Approval	Aust Safety Standard AS3100, AS3105



NEW FROM JAYCAR

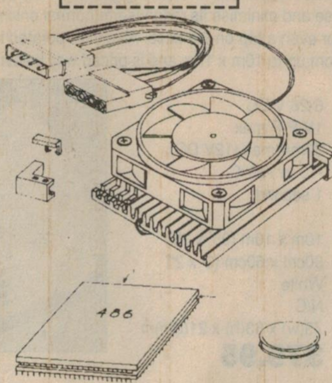
Cat. MS-4002 **$79.95**

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CPU COOLER

NEW FROM JAYCAR

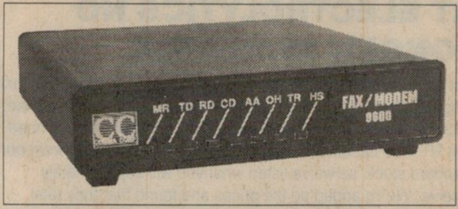
Is your 486 running too hot? Do you live in the hotter areas of Australia? Many CPU's run too hot. With our new CPU cooler you can forget all that.
The CPU cooler is easy to mount, you don't need to remove the CPU. It incorporates a heatsink which clips over the CPU and is held there by a special clip. It's supplied with a piggyback plug arrangement for power. Simply unplug the power connector inside and plug the CPU cooler in-line. Installation should take all of about 3 minutes.



Cat. XC-5040
ONLY $39.95

Comma Corp Fax/Modem 9600

The Comma Fax/Modem will turn your PC (or Macintosh) into both a fax machine which can transmit faxes up to 9600 baud, as well as a Modem which supports both 1200 and 2400 baud.



The Comma Fax/Modem uses the latest technology in digital signal processing to ensure lasting trouble free operation.
The Comma Fax/Modem is a fully featured fax machine similar to units costing over $1000, which will transmit and receive faxes at up to 9600 baud.
Your faxes can now be sent directly from your PC without having to print them first. Programs supported such as Ventura Publisher, WordPerfect, Windows, TIFF and Dr Halo to name but a few.
You can view incoming faxes on-screen or print them using a standard dot matrix printer. Incoming files can also be exported in either TIFF or PCX formats for use in popular graphic packages.
Only print the faxes you want to keep - just think of the savings on expensive fax paper.
The Comma Fax/Modem will also receive faxes in background while you continue to work.
When faxing out, the Fax/Modem will redial an engaged number so you can be sure your faxes are sent. The software also automatically keeps a complete log of both incoming and outgoing faxes.
Also supported are cover pages, broadcast faxes, and scheduling. The software keeps a database type register of regularly used fax numbers for easy retrieval.
The Comma Fax/Modem is a fully AT command compatible modem. Features include V22/V22bis standards both 1200 and 2400 baud rates are supported as well as auto answer, dialling and disconnect. You will find it compatible with all popular communication software.
FREE Software
With each modem you will receive the QL2 Fax/modem software featuring both pull -down and mouse support.

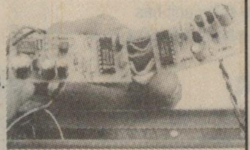
Cat. XM-5000 **ONLY $349**

NEW FROM JAYCAR

THE LATEST KITS

DIESEL SOUND SIMULATOR KIT

Ref: SC December 1992
This project is virtually identical to our steam sound simulator kit, and is designed to mount inside the loco, providing scale is HO or larger. Measuring just 102 x 25mm this diesel sound kit will compliment any layout with diesel locos. PCB. mylar speaker and all electronic components supplied.



Cat. KC-5126
$12.95

NEW FROM JAYCAR

LOW COST INDUCTANCE ADAPTOR KIT FOR DMM's

Ref: EA December 1992

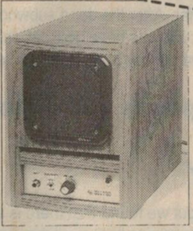
Measuring the inductance of wire-wound components has not been easy until now, but here's a handy adaptor unit which allows the job to be done with a standard digital multimeter. Operating from a single 9V battery and will measure virtually any of the inductances used in audio and similar circuitry with values in the micro Henry - milli Henry range. Kit includes PCB, case, all components. 9V battery required Cat. SB-2370.

Cat. KA-1746 **$39.95**

NEW FROM JAYCAR

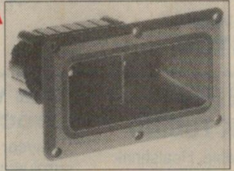
'MULTIMEDIA' AMPLIFIER KIT

Ref: EA December 1992
This project was originally designed to be used with computer sound-cards, and CD-ROM players to bring games and other software 'to life'. It can also be used with portable CD players and video equipment. Just the shot for improving the sound from your computer or CD player! The kit is supplied in short form, i.e. no speaker (use Cat AS-3011), box, transformer (use Cat MM-2006) or hardware. PCB and all electronic components supplied.



Cat. KA-1747 **$24.95**

MOTOROLA KSN1177A TWIN DRIVE "TD" BULLET TWEETER



Increase your top end response for band PA bins or even your own home Hi-Fi speakers. This bullet provides a new high tier look with outstanding accoustic performance. The TD bullet is rated at 99dB (1m/1w) with exceptional smoothness over the operating range 3.5kHz to 20kHz. Power handling is 100 watts.

Cat. CT-1926 **$39.95**

JAYCAR No. 1 FOR KITS

ASSORTED SPAGHETTI PACK

NEW FROM JAYCAR

This new pack contains a handy assortment of quality PVC tubing. Sizes vary from 90mm to 3m in length and 1mm to 9mm in diameter, in up to six different colours. This pack is ideal for hobbyists as spaghetti tubing is becoming increasingly difficult to obtain in these sizes. Grab one for the 'junk box'!

Cat. WS-5502 **$3.96**

BLACK LIGHT GLOBE

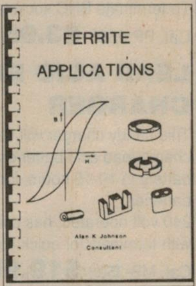


Great for parties. It's an incandescent lamp with ultra violet coating. Will fit any 240V AC standard globe socket. Rated at 75 watts.

Cat. SL-2760 **$9.95**

NEW FROM JAYCAR

AT LAST - A BOOK ON FERRITE MATERIAL & APPLICATIONS



This is one subject that is very difficult to find any information on. Magnetic cores are the foundation for transformers, inductors and chokes used in so many of our electronic projects. This book is intended to be used by persons who want to (or have to) work with ferrite materials, but are not well versed in magnetics or ferrites and cannot justify outside consultation.
Some of the problems addressed are:-

- How to select the right type of material
- How to identify an unknown material
- How to measure material properties and much more

NEW FROM JAYCAR

Written in 1991 by A. K. Johnson. This book is due to arrive sometime in January - hopefully, the first half. Softcover, ringbinder. 82 pages 212 x 132mm.

Cat. BC-1125 **$18.95**

NEW CANBERRA DEALER

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Phone: (06) 241 5900
Fax: (06) 241 6244

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END OF AN ERA!
RT ELECTROLYTICS NO LONGER AVAILABLE

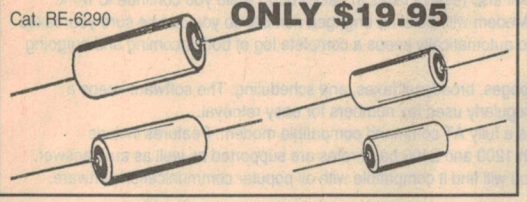
Our two major capacitor suppliers have discontinued the RT (axial) range of electrolytics. So, we have made up some unbelievable packs of these. So, grab yourself a pack for when you will need that RT. The capacitors used in these packs are mostly from our standard stock, so we've listed what you will approximately receive. We've added up the prices and found that they total $101.00 if bought at normal prices. The pack contains 100 electros at at $19.95 represents an absolute bargain. Grab a pack while we've got them.

This is approximately what's in the bag, we reserve the right to make changes if shortages occur.

1µF/63v x 3, 2.2/63 x 3, 4.7/63 x 4, 10/63 x 4, 10/160 x 4, 25/25 x 3, 25/63 x 5, 47/16 x 11, 47/25 x 7, 47/63 x 1, 100/25 x 3, 100/63 x 8, 100/450 x 1, 220/25 x 6, 470/16 x 7, 470/25 x 4, 470/50 x 13, 1000/12 x 1, 1000/25 x 2, 1000/35 x 1, 1000/63 x 1, 2500/16 x 2, 2500/25 x 3, 2500/35 x 1, 3300/16 x 1, 4700/35 x 1

100 RT ELECTRO's - over $100 value

Cat. RE-6290 **ONLY $19.95**



GLASS BREAK DETECTOR

At last, a reasonably priced, quality Glass Break Detector. The LA-5195 is an acoustic glassbreak detector designed to listen for specific sonic frequencies of breaking glass. It's equipped with multi-level discriminating circuitry to maximise its response and minimise its response to normal environmental noises. It will not alarm in response to a slamming door, or even a tap on the case. Also incorporated is a sensitivity adjustment potentiometer. It will cover a room up to 10m x 10m and is priced well below others of the same quality.

Specifications	
Voltage input	6-26 V DC
Supply Ripple	1V P-P max
Current	20mA max (12V DC)
Operating Temp.	-10 to +50°C
Alarm Duration	1 second
Coverage	
Max Sensitivity	10m x 10m (35' x 35')
Min Sensitivity	60cm x 60cm (2' x 2')
Colour	White
Output Terminals	N/C
Size	75(w) x 63(h) x 21(d)mm



Cat. LA-5195 **$79.95**

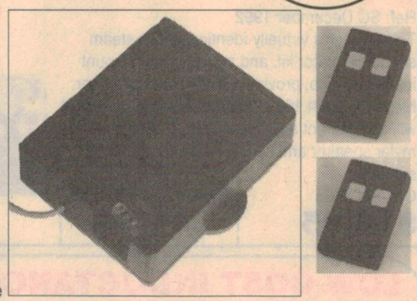
REMOTE CONTROL SWITCH
(Wireless Receiver/Transmitter)

NOW IN STOCK

Why build a kit when you can buy a built unit for only $10 more and it's guaranteed At last a quality Remote Control unit with two transmitters for under $100!

THE TRANSMITTERS

The keyfob has two buttons on them, one LOCK and one UNLOCK with a LED to show unit has transmitted. Size is normal keyfob size 60 x 35 x 14mm and has a keyring.



THE RECEIVER

It's a black box with a 4 way terminal block for external connections. These are for +12V, -12V, LOCK and UNLOCK.

FEATURES

There are separate outputs for lock and unlock which are both momentary (approx. 0.5 seconds). There are two separate relays one for lock and the other for unlock, which will switch currents up to 2 amps. which is adequate for most applications. There is also a switch which allows the output relays to switch either to ground or to +12V to an external control circuit. Both transmitters and receiver have DIP switches for coding. There are 6,561 different codings available. Remote control range is 28 metres. Ideal for controlling central door locking, car alarms, etc., etc. Supplied with two transmitters and one receiver.

Cat. LR-8822 **$79.95**

EXTRA TRANSMITTERS NOW AVAILABLE Cat. LR-8823 **$19.95**

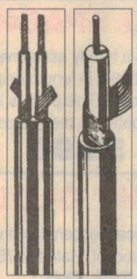
NEW PRODUCTS

HIGH QUALITY AUDIO CABLE

If you wanted better quality audio cable than our standard range, it's been a problem up til now. Our new high quality audio cable is ideal for wiring up amplifiers, making audio leads, etc., etc. Made in Australia.

Specifications

	Single	Fig 8
Nearest AWG size	25	27
No/dia wire mm	14/0.122	14/0.122
Insulation thickness	0.38	0.38
Nominal OD mm	2.75	5.2 x 2.5
Screen	Spiral lapped tinned copper	
Insulation	Polythene	Polythene
Colour	Black	Black



SINGLE
Cat. WB-1506
$2 metre
$125/100mt roll

Fig 8
Cat. WB-1507
$3.95 metre
$245/100mt roll

BNC TERMINATOR PLUG

To terminate BNC sockets with a 50Ω resistor.

Cat. PP-0655 **$3.95**

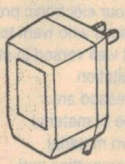


LEAD ACID BATTERY CHARGER

This handy charger will deliver 450mA to trickle charge lead acid batteries. Will charge a 4.5Ah battery in 10-15 hours, longer for higher current batteries.

240 volt operated, has colour coded output lead with terminals for quick connect to batteries.

Cat. MB-3508 **$19.95**



CLEAR HEATSHRINK TUBING

All our current sizes of heatshrink are now available in clear. Ideal where you need to see under what has been heatshrunk. Shrinks to 1/2 size. The size shown is before shrinking.

Size	Price	Clear	Red	Black
1.5mm	$1.85	WH-5550	WH-5530	WH-5540
2.5mm	$1.85	WH-5551	WH-5531	WH-5541
3.5mm	$1.95	WH-5552	WH-5532	WH-5542
5mm	$2.25	WH-5553	WH-5532	WH-5543
7mm	$2.50	WH-5554	WH-5534	WH-5544
10mm	$3.00	WH-5555	WH-5535	WH-5545
16mm	$4.50	WH-5557	WH-5537	WH-5547

HIGH POWER SUBWOOFER KIT



See Electronics Australia January 1993

Build a 200W rms subwoofer. After the June subwoofer article which featured our 8" subwoofer, EA was beseiged with requests for a higher power unit. They have used our Re/Sponse 12" driver and we have had cabinet kits made to suit.

SPEAKER Re/Sponse 12" driver Cat. CW-2145
$199

CABINET KIT

The cabinet is not cheap, but we found that there is an enormous amount of work for the home constructor to line up all the wood, drill and screw. Our cabinet kit is made from 18mm MDF customwood, as recommended in the article. There are 64 holes pre-drilled to fix the 32 x 50mm screws supplied and needed for strong assembly. The baffle has been routed and the T nut sockets are in place to mount the driver. There is a 50mm round hole to mount the rear terminal which is supplied. The MDF customwood is supplied in a natural state with a view to painting it.

Cat. CS-2485 **$189**



LARGE HEAT-SHRINK TUBING

Now available, Heatshrink Tubing with a 32mm (1 1/4") diameter. Ideal for Sub C batteries, big wiring looms, etc. Colour is black. Length 50cm (1/2 metre). Shrinks to half size.

Cat. WH-5539 **$5.95**

TURN YOUR SURPLUS STOCK INTO CASH!

Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for osurces of prime quality merchandise.

Call Mark Harris or Bruce Routley NOW on (02) 743 5222

BECOME A JAYCAR DEALER

Contact our wholesale Department on (02) 743 5222

BUY IN BULK & SAVE

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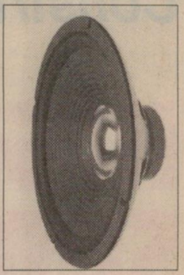
WOOFER SENSATION

Stock up now on these amazing speaker bargains. They are quality woofers with foam roll surrounds, silver dust cover and ribbed grey cardboard cones.
Brief specifications - 10" and 12"
Impedance 8Ω • power handling 10" 60 watts 12" 80 watts • resonant frequency (approx.) 10" 38Hz, 12" 35Hz • frequency response 10" 38 - 3000Hz, 12" 35 - 2000Hz • suitable enclosure size (sealed cabinets) 10" 25 litre or more, 12" 40 litre or more.
Please note - these are the only specifications we have available.

10" SPEAKER Cat. CW-2117 **ONLY $20 ea**
12" SPEAKER Cat. CW-2123 **ONLY $27.50**

BELOW 1/2 PRICE

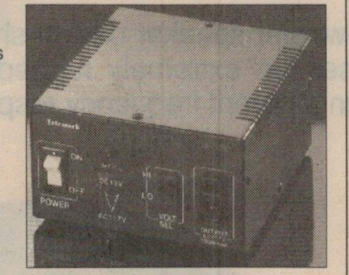




NEW 100 WATT 12 - 240 VOLT INVERTER

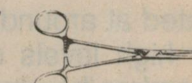
If you don't need 300 watts then this brand new 100 watt version may just do the job. Made by the same company that makes our 300 watt and 500 watt units, we found this inverter to work exceptionally well. It has good overload protection and the circuit breakers will trip if 110 watts is exceeded over a long time. It has a Hi/Lo voltage switch, efficiency is 82% Hi and 86% Lo. It is not suitable for - refrigeration, motor, compressor, phase shift control equipment (e.g. electric blanket).
Supplied with lead and cigarette lighter plug. SAVE $60 OVER PREVIOUS MODELS.

Cat. MI-5035 **ONLY $129.50**



SCISSOR CLAMPS

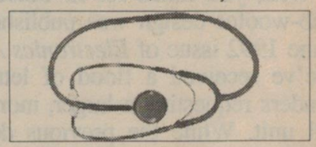
These clamps are made of stainless steel and can be locked on to the item they are holding. They are 130mm long, so are ideal to reach into hard-to-get-at places. Also great for holding components etc., whilst soldering.



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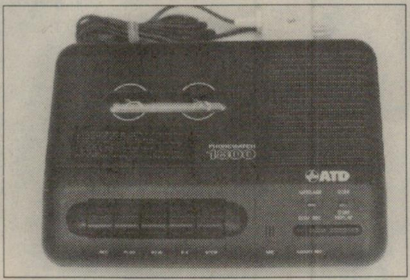
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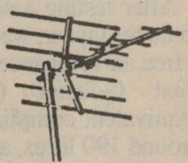
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Construction project:

HIGHER POWER SUB-WOOFER DESIGN

Rated at around 200 watts, this new sub-woofer speaker design should satisfy those with the thirst for high levels of low bass energy. It uses an extremely rugged 300mm speaker in a double-chamber 'bandpass' enclosure, and has an inherent frequency response of 30Hz to 100Hz (-3dB).

By ROB EVANS

Well, you asked for it! Since our last sub-woofer design was published in the June 1992 issue of *Electronics Australia*, we've received a flood of letters from readers requesting a larger, more powerful unit. While the previous design offered excellent performance from a relatively small enclosure, using a 200mm driver, the nominal power rating was a mere(!) 80 watts — which was clearly not enough for some readers...

So with the need established, we set about tracking down a high-powered driver which would be suitable for the same bandpass-style of enclosure as used in the last design. Our search ended with a hefty 300mm unit from Jaycar Electronics, which is the largest in their 'Re/sponse' brand range. Listed as catalog number CW-2145, this driver carries a generous 200W RMS power rating and is priced at $199 — not bad, when you consider that this is the main outlay for the new sub-woofer.

After testing a sample unit kindly sent to us by Jaycar, we established that it had a free air resonance (Fo) of about 29Hz, a total Q-factor (Qts) of 0.34, an 'equivalent compliance volume' (Vas) of around 190 litres, and a very encouraging sensitivity figure of 93dB (for 1W at 1m).

Physically, the driver offers a 'woven carbon fibre' cone, a stout 1.4kg magnet assembly, and interestingly, a *dual* 'kapton' voice coil which allows you to connect it as an 8-ohm or 4-ohm unit.

We initially regarded this latter feature as a significant advantage for sub-woofer applications, since many amplifiers are able to deliver a much higher power level into a 4-ohm speaker, which ultimately adds up to a more cost-efficient arrangement.

Rather strangely however, further testing revealed that the driver's Qts figure



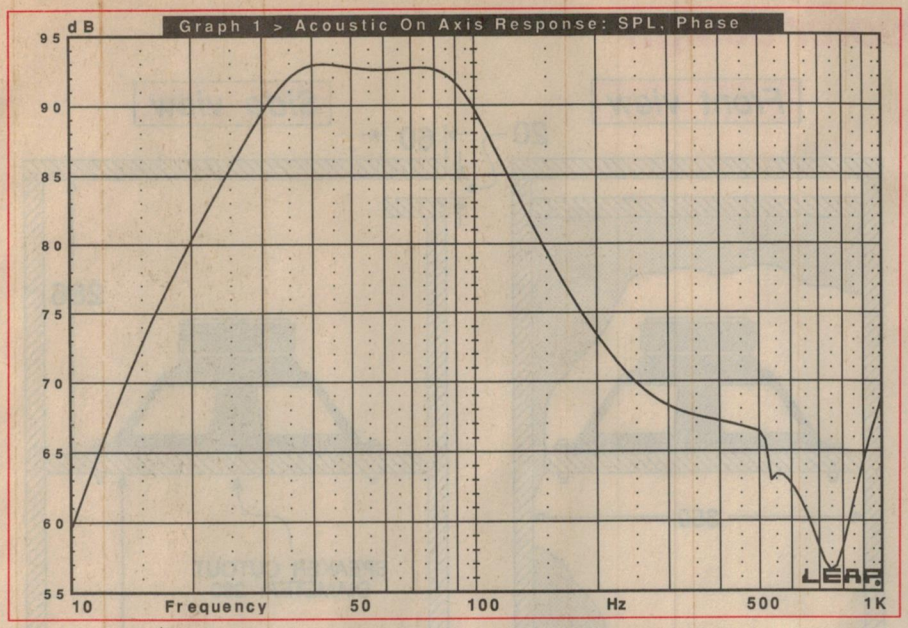


Fig.1: The sub-woofer's projected frequency response at 1W/1m. The slight aberration at around 500Hz is due to reflections inside the enclosure's ports.

rose to 0.68 when connected as a 4-ohm unit — *double* the 8-ohm figure. And to put it bluntly, a driver with such a high Q factor was just not suitable for our purposes (or too many others, for that matter).

Curiosity aroused, we had a closer look at the measurements for the driver in its 4-ohm configuration, and noticed that the fundamental 'BL' factor (which has a direct bearing on the driver's Q) was half of that measured in the 8-ohm tests. Now, since a driver's BL figure represents the length of wire in the magnetic field multiplied by the field density (in Tesla-metres), it seems that there must be half the amount of wire used in the 4-ohm configuration — since clearly, the magnetic field density remains the same.

So in effect, the Re/sponse driver appears to have a *tapped* voice coil, and since only half of the windings are used in the magnetic gap with the 4-ohm connection, there is a resulting decrease in the voice coil's driving force. Therefore as a 'motor' unit, the coil has less control over the cone movement, which adds up to a much higher electrical Q factor. As further evidence, we noticed that the driver's sensitivity is about 3dB lower in the 4-ohm mode (90dB as opposed to 93dB).

As you have no doubt gathered then, our new enclosure design is intended for the Re/sponse driver wired as an 8-ohm unit only. The driver's parameters in this configuration are well suited to the bandpass style of enclosure, which was duly developed with the help of our resident LEAP (Loudspeaker Enclosure Analysis Program) software. The result is an enclosure of about 138 litres in volume which stands about one metre high, and radiates sound via two slotted vents positioned at the extreme ends of the front panel. In acoustic terms, it has a natural bandwidth of 30Hz to 100Hz (see Fig.1), and theoretically delivers a maximum sound pressure level (SPL) of about *115dB* at a distance of one metre.

While the double-tuned bandpass design ends up a little larger than an equivalent vented enclosure, it does offer a number of distinct advantages for sub-woofers in particular. In short, these are a lower average cone excursion and velocity, less audible overtones heard from the cone itself, and a natural high-frequency roll-off — these points were also covered in more detail in the original June 1992 article, by the way.

These features mean in turn that the bandpass design tends to sound much 'cleaner' (less distortion products), and is less demanding of the crossover filter.

So there you have it. It's big, it's powerful, and it won't break the bank. Just remember, when the neighbourhood starts complaining about seismic activity which seems to be emanating from your house, that *you* asked for the thing...

Construction

Before you start building the cabinet for the new sub-woofer, we would suggest that you read through the complete article, since as detailed later, the design may need to be slightly changed to suit your components and/or preferences.

As you can see from the assembly diagram (Fig.3), the bandpass style of enclosure is a more elaborate arrangement than the common highpass (vented or sealed) type, and consequently, will take rather more effort to construct. On the brighter side however, a precision finish is not really necessary since the cabinet will probably be painted in a dark colour, and installed in an inconspicuous location. This in turn means that simple butt joins can be used, and minor woodworking errors won't really show.

The enclosure should be constructed from 19mm (or even 25mm) high-density particle board (commonly known as

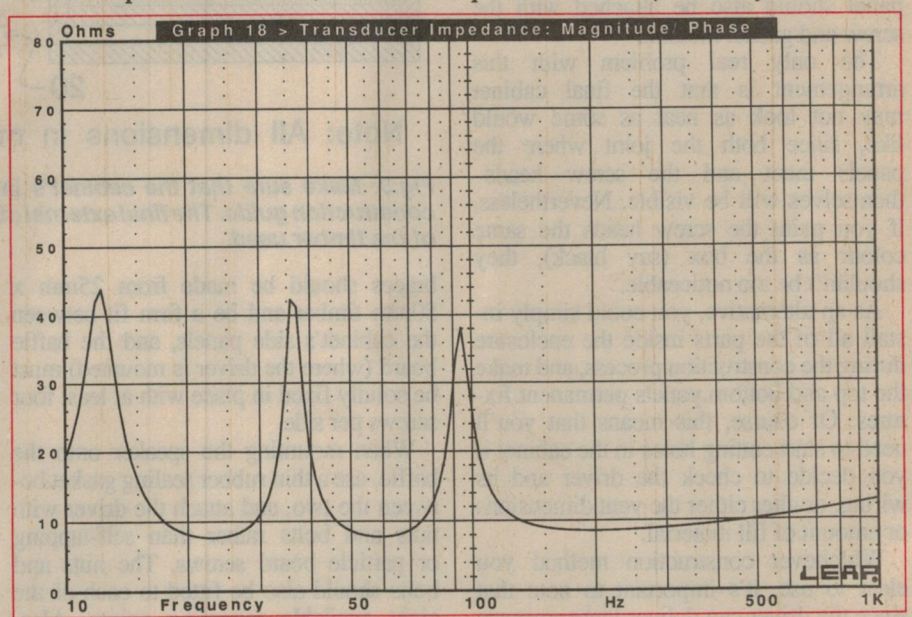


Fig.2: The impedance curve shows the distinct triple-hump characteristic of the double-tuned bandpass design — the dips represent the tuning points of the two ports.

MDF), with each joint both screwed *and* glued together for an air-tight and sturdy result. We would recommend that you use coarse-threaded particle board screws that are at least 50mm long, and liberal amounts of woodworking glue for each joint.

Note that the ease with which cabinet can be put together and the quality of the result will depend upon the accuracy of the original saw-cuts, which should have clean, straight edges, and be at 90° to the main surface. Some kind of bench or drop-saw is really needed to achieve this sort of accuracy, so your best bet would be to arrange for the box panels to be cut using professional equipment — a timber yard or joinery should be able to provide this service.

On the other hand, unlike yours truly, some constructors may be sufficiently skilled with a hand-held circular saw to produce acceptable results. Remember though, that all joints should be fully air-tight, and mistakes will be expensive if you need to buy replacement timber.

You will also need to consider how you plan to access the driver, wiring and damping material once the enclosure has been completed. With our previous bandpass enclosure design, the 'bottom' panel was screwed (but not glued) in place and a rubber gasket used to maintain the air seal. In the case of our new sub-woofer however, you really need to have access to both the top *and* bottom compartments, which means that the top panel should also be attached with the screw and gasket method.

The only real problem with this arrangement is that the final cabinet may not look as neat as some would like, since both the joint where the panels meet and the screw heads themselves will be visible. Nevertheless, if you paint the screw heads the same colour as the box (say black), they shouldn't be too noticeable.

As an alternative, you could simply install all of the parts inside the enclosure during the construction process, and make the top and bottom panels permanent fixtures. Of course, this means that you'll need to start cutting holes in the cabinet if you decide to check the driver and its wiring, or alter either the vent dimensions or amount of fill material.

Whichever construction method you elect to use, it's important to note that since the driver can deliver large amounts of acoustic energy, the cabinet must be very solidly constructed and free from panel resonances. To this end, the internal

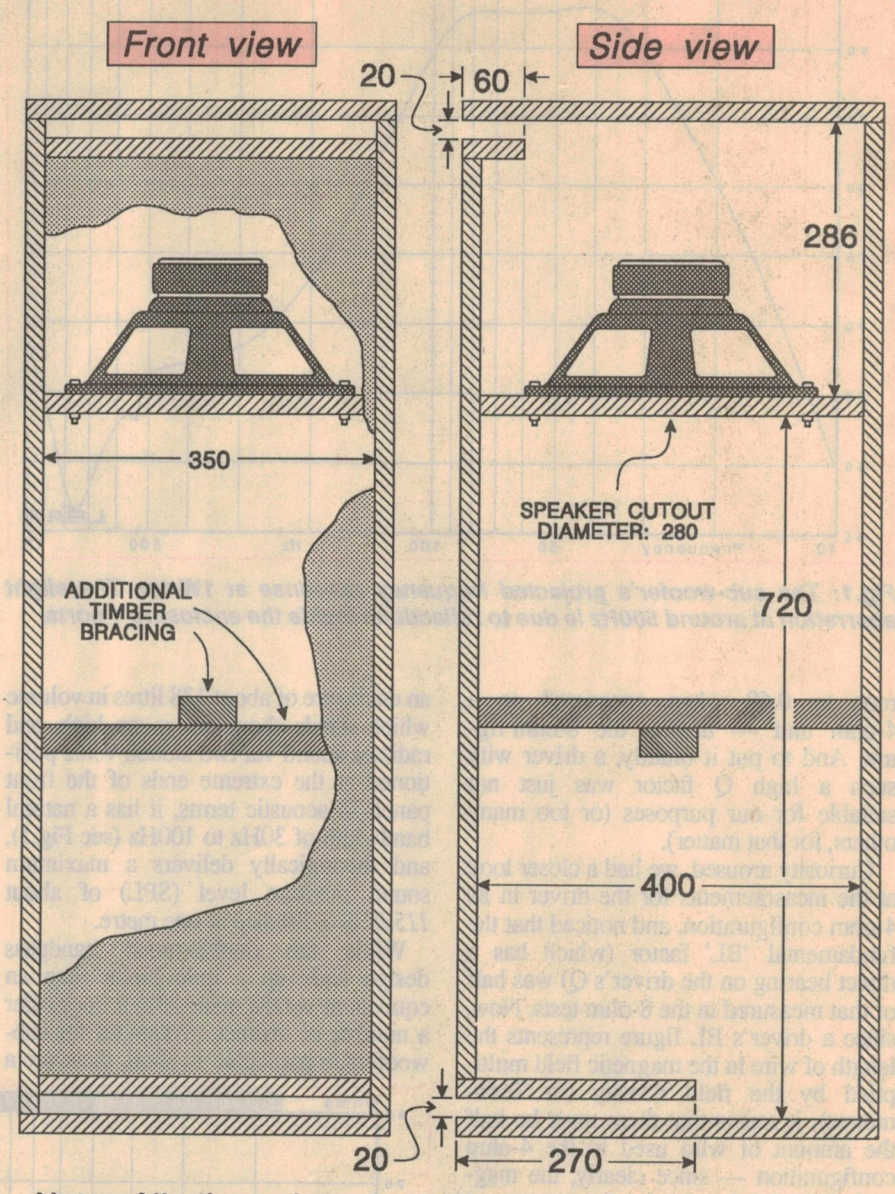


Fig.3: Make sure that the cabinet's internal dimensions are as shown in this construction guide. The final external dimensions will depend upon the thickness of the timber used.

braces should be made from 25mm x 50mm timber and be a firm fit between the cabinet's side panels, and the baffle board (where the driver is mounted) must be solidly fixed in place with at least four screws per side.

When mounting the speaker onto the baffle, use a thin rubber sealing gasket between the two, and attach the driver with nuts and bolts rather than self-tapping or particle board screws. The nuts and bolts should also be fitted to each of the eight available mounting points. Also, make sure that the speaker wire is of a heavy duty type, and is positioned where it cannot come into contact with the driver's cone. And remember, use the *8-ohm* voice coil connections (the two outer terminals).

The sub-woofer's power capability also means that the velocity of the air in the vents can reach very high levels, which can lead to audible turbulence effects as the air rapidly flows past any sharp edges. This can be minimised by slightly rounding the lips of the vent openings, at the outside *and* inside inlets — don't overdo it though, or you might significantly alter the volume of air in the port and effect the cabinet's tuning.

As a last point, we should mention that the enclosure has been designed and

tuned with a moderate amount of acoustic damping material in mind. For the upper chamber, drape a square of the material (about the size of the top panel) over the driver and tack or staple the ends in place, so that it cannot come into contact with the speaker's cone.

For the lower chamber, we would suggest using two pieces of acoustic material; one for the section above the braces, and the other for the lower area between the braces and the vent. Referring to the side view of the enclosure as shown in Fig.3, the lower piece can be stapled between the bottom left-hand corner (just above the port) and the right-hand end of the braces, in a diagonal position — this keeps the material well away from the port opening, where it could audibly 'flutter' due to air turbulence.

The other section can be fitted to the top of the chamber in the same diagonal manner, with one end secured at the left-hand end of the braces (the enclosure's front panel, in fact), and the other below the right-hand end of the baffle board (the rear panel). The damping material itself can be formed from fibreglass home insulation 'batts', or a proprietary acoustic wadding such as Innerbond or an equivalent product.

Note that in its 25mm thick form, this latter fill material appears to have about half of the damping effect of the fibreglass batts, so you will need a double layer for each of the three sections. However this material won't irritate your skin or tend to break up like fibreglass batts, so the few extra dollars may be well spent.

Checks

It's an unfortunate fact of life (or manufacturing) that a driver's parameters will tend to change between production runs, and the performance of a number of 'standard' speakers in a given enclosure may not be consistent.

While the more conventional highpass designs (sealed and vented) are reasonably tolerant to these changes, a bandpass enclosure is much more interactive with the driver and can therefore respond quite dramatically to a shift in its specifications.

After performing a number of trials with LEAP, it soon became apparent that a shift in the driver's free air resonance (Fo) seems to have a significant effect on the cabinet's final performance, while changes in the other essential parameters — Vas and Qts — will produce relatively minor aberrations.

We also found that a change in these latter parameters tends to be accompanied by a substantial shift in Fo, so the resonance figure turns out to be a reasonable yardstick for detecting a variation in the driver's specifications — and as a bonus, it's also the easiest figure to test. In fact we would recommend that you determine the driver's free air resonance *before* you build the enclosure, so that the cabinet can be re-tuned to minimise the negative effects of any change.

The simplest way to test the driver's Fo is to measure its impedance over the 10Hz to 100Hz range, and note where the response peaks due to its natural resonance. To do this, suspend the driver above the floor by placing it between two flat surfaces (a couple of tables are ideal) so that it's only held at two points around the perimeter. Then connect an audio oscillator as a signal source, and monitor its output voltage with a multimeter or oscilloscope.

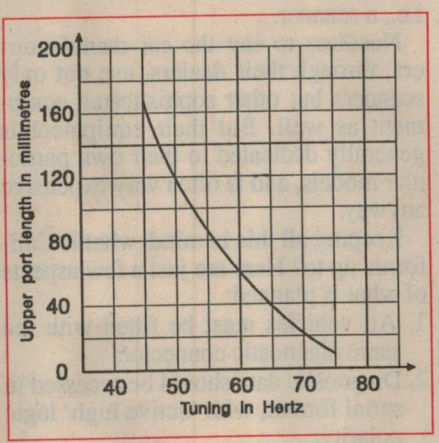


Fig.4: If necessary, use this 'tuning' graph to alter the length of the enclosure's upper port (see text).

Providing the oscillator has a relatively high output impedance (greater than 100 ohms, which is usually the case), you should see a dramatic increase in its output level as you sweep the frequency past the driver's resonant point. In the case of the 12" Re/sponse driver, the peak should occur at about 29Hz.

If the figure from your test differs by more than about 2Hz, you will need to retune the enclosure's *upper* vent by around the same figure to bring things back into line. For example, if the driver's Fo is 5Hz too high (34Hz), you need to tune the top enclosure to about 65Hz rather than 60Hz.

To help you with this process, we've included a vent length versus tuning frequency graph for the upper port, as shown in Fig.4 — so in the above example, the length will need to be reduced to about 38mm. Conversely, if the driver has an Fo of 24Hz (5Hz low), you will need an 85mm upper vent (55Hz).

While on the subject of impedance tests, some constructors may wish to check that the final enclosure is indeed tuned to the correct frequencies, indicating that it will perform as specified. In this case the same impedance testing method can be used to determine the tuning points of the two chambers, by noting the frequency of the two *dips* in the impedance curve, as shown in Fig.2.

As you would expect, the dip at around 23Hz corresponds to the tuning of the lower vent, while the 60Hz dip is due to the action of the upper vent. If these are more than a few Hertz out from what is expected, double check that the enclosure and vents are indeed the correct dimensions, and the specified amount of fill material has been installed. Also, remember that if you have retuned the top vent to compensate for the driver's parameters, the final impedance curve will reflect this change.

Setting up

Once you are happy with the sub-woofer's construction and tuning, you will need to decide how it will be connected to your existing hifi system and where it might be placed in the listening room. As you would expect, both of these decisions will play a large part in determining the quality of the final sound, and should be given as much attention as the construction project itself.

In short, we would recommend using *EA* Sub-woofer Adaptor (published in the May 1989 issue) for deriving an appropriate signal from the existing system, driving an amplifier with a power capability of at least 100W. We also suggest placing the sub-woofer enclosure against the wall, but away from the corners of the room.

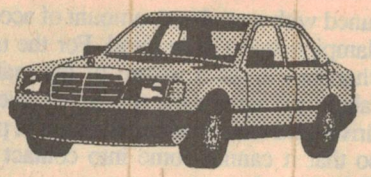
There are a number of other variables to consider, such as the acoustic balance between the two speaker systems, their phase relationship, and the most appropriate crossover frequency.

We'd suggest that you refer back to the June 1992 sub-woofer article for further information on these points, which were discussed in some detail in the 'Setting up' section.

Above all, it's really just a matter of experimenting with all of these factors, within the constraints of the existing system's capabilities and the layout of your listening room.

There will no doubt be some clear (possibly spouse-induced) restrictions on where the sub-woofer can be be positioned, for example. Once you have the system up and running however, you should find that your new sub-woofer has an extremely clean and extended output, and can effortlessly deliver very large amounts of low-frequency energy. ❖

AUTOMOTIVE ELECTRONICS



with MAJOR AL YOUNGER (USAR, Ret.)

An introduction to automotive data scanners — 1

If you haven't struck one yet, a 'scanner' in the automotive electronics context is a hand-held device that allows the user to access the vehicle's control processor and retrieve diagnostic information from it. I predict that in the future, 75% of the world's cars will be fixed using them.

Virtually all vehicles that have an electronic control module (ECM) for engine management control offer some form of retrieving diagnostic data from it. This also applies to vehicles with electronic controlled transmissions (ECT). This data may be in the form of fault codes, a data stream (active data), or both.

Some systems allow *interaction* — meaning control signals can be sent *to* the ECM, as well as data retrieved from it. The original purpose of providing this access to ECM information is as an aid in troubleshooting. Some systems require special equipment to access the information. The hand-held scanner (Fig.1) performs this function, and often rather more besides.

Another use

It used to be an assumption (at least by Americans) that the way North America goes, in motoring, so goes the world. But as far as emission and pollution controls are concerned, the world tends to go the way *California* goes...

California's emission standards exceed all federal standards in North America. Many vehicles sold, and even manufactured, in North America, cannot be registered in California. As this is being written, California is planning to 'outlaw' leaded fuels and introduce methanol-mixed fuels. It's about time, as there are over 28 million motor vehicles in southern California.

What does all this have to do with scanners? To answer that question, you need to understand the purpose and usage of the scanner. The purpose is to provide all information available from the ECM. The usage, of course, is by motor mechanics. Independent mechanics fix 75% of the world's vehicles. Data may be retrieved from the ECM by other means, of course, but the scanner is the least expensive. So a fair statement is, most cars will be fixed using a relatively low cost hand-held device — i.e., a scanner.

Needless to say the car manufacturers, through their dealers, use not only scanners but other sophisticated equipment as well. But their equipment is generally dedicated to their own particular models, and is often very expensive anyway.

Keeping all this in mind, what is California up to? Here are just a few aspects of what is planned:

1. All vehicles must be fitted with the same diagnostic connector;
2. Diagnostic data should be accessed in serial format, with 'active high' logic polarity;
3. There must be a visual indication for emission or pollution control failure;
4. There must be an oxygen sensor;
5. All failure information must be stored in a memory, to allow later retrieval; and finally...
6. The diagnostic codes must be standardised.

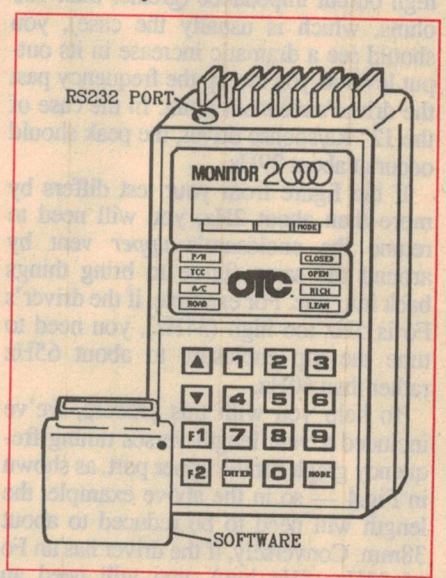


Fig.1: A typical handheld scanner has a keyboard and display, and plug-in software (firmware) modules.

There's more, but you can probably see where they're heading. Ultimately all vehicles are going to have the same serial interface and connector, using a standard diagnostic code and memory storage of failure information. So a scanner will be able to be used not just for diagnostics, but for monitoring a car's emission performance.

Yes, the day is fast approaching when you'll be stopped and your vehicle is connected to a machine to see if it meets the pollution specs. How much information will be accessed, is a matter of the legal system. Since some ECM's even store the vehicle's highest speed achieved, there's even the potential for your ECM to be used for 'self incrimination' if you have exceeded the speed limits.

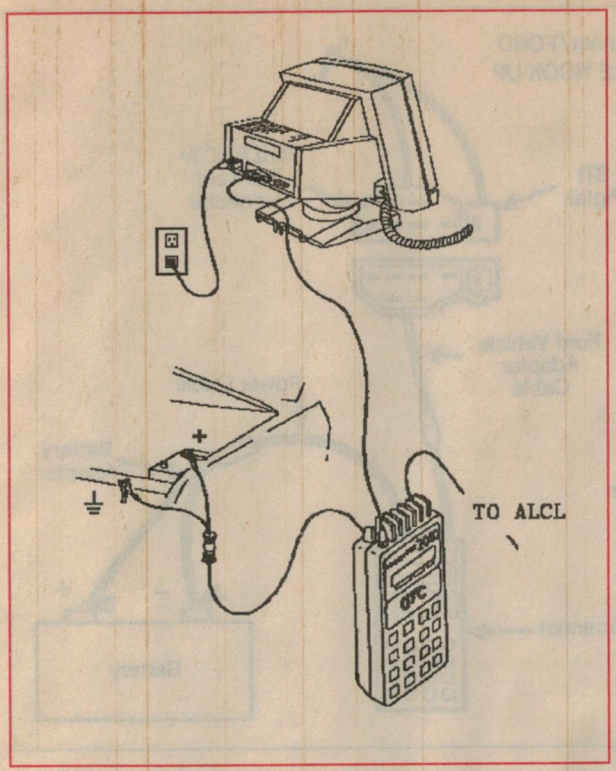
So now we can see the basic requirements for a scanner. In a nutshell, it must be capable of obtaining all data available from the ECM, storing it and providing a convenient means of displaying it. I like to describe this as 'hooking up to the ECM so that it can talk to the world'.

The sophistication of today's automotive electronics demands this kind of fast, convenient access to the ECM's internal 'brain', if servicing and adjustment are to be carried out economically.

Background history

None of the first ECM's provided access to the outside world, which meant that they couldn't be serviced in the field. Luckily this phase didn't last long.

Even when diagnostic connectors were provided, the scanner manufacturing industry took years to get its act together. Needless to say a scanner is itself a small computer, and it requires software — or more strictly, *firmware* (software in a ROM chip). And this



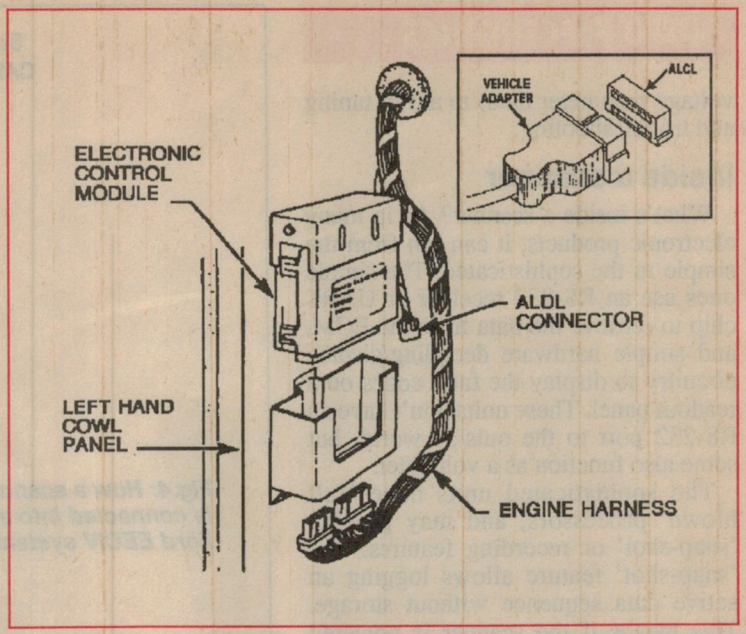


Fig.2 (above): In VN Holdens, the 'ALDL' (assembly line diagnostic link) connector is at the side of the ECM, behind the left kick panel.

Fig.3 (left): The more sophisticated scanners have an RS-232 serial port, so the data can be accessed and examined using a PC.

firmware generally needs to be updated pretty often, to cope with new models (on some cars, the ECM software can change yearly).

The first scanners also required a return to the factory for updating their firmware. After a few manufacturers went broke, plug-in firmware became available. The pioneer in this field was Superior Electric, an old manufacturer of electrical test meters. Their interest in scanners was sold to OTC (Owatonna Tool Company), a division of Sealed Power (of piston ring fame). Nowadays both are under the new banner of SPX.

As scanners proliferated, so did the competition. Not only did price wars develop, but also features. The industry, by now, had decided that the units must not become obsolete, because of a factory system or model change.

Soon the modular or system approach was taken. One could purchase a 'bare bones' scanner and add on options later. Then another approach was taken, which found features built in — such as the ability to record. When OTC introduced its System 2000, with an RS-232 port, many companies folded or changed owners.

But the industry still had a problem — simplicity. Some scanners were not very 'user friendly', and required extensive training. One button pushed out of sequence would either lock up the scanner or worse yet, give bad data.

The smart companies provided step by step visual instructions for operations, on the scanner's own display. So nowadays, just reading the display guides one through a procedure.

Does that mean everything is done for you? No — the hardest part is still there: interpreting the information.

The vehicle

So how are scanners used? First off, it depends upon the vehicle and its manufacturer. Some do not provide data, while others provide data, but have no access for a scanner. On some, the fault codes are read on the 'check engine' lamp or those for other functions. And some manufacturers don't provide retrieval data.

If you do not know what is applicable to your vehicle, ask your mechanic. There are too many models and systems to list here. Part of using a scanner is knowing what cars it will hook up to.

Every year more vehicle manufactures incorporate the data stream system, where the ECM delivers a constant stream of information. In 1991 Toyota's Cressida and Lexus models joined this group. It aids the manufacturer in assembly line final testing, allows collection of functional data on the road (the real world), aids diagnostics, and will soon be required by law — at least in California.

How they're used

ECM vehicles that accept a scanner are provided with a diagnostic connector. In shop talk it is the 'diagnostic lead' or the 'ALDL' (assembly line diagnostic link) connector. The latter name is GM-Holden terminology. The same company also talks about an 'ALCL' (assembly line communication link) — it's the same connector. The names used depends upon the function.

Finding the ALDL is another matter. On early Holdens it's under the instrument panel; on VNs it's behind (above) the left kick panel (Fig.2). On Fords and most others, it's under the bonnet.

The data retrieved consists of *fault codes* and *active data*. Fault codes are basically numbers, each representing a particular sensor or system fault. If no fault code appears, most scanners will indicate a pass code. Some ECM systems store previous fault codes, allowing logging of an intermittent failure. If an ECM system fails to give any kind of fault codes, there is a problem.

For cars with ECMs that also deliver active data, suitable diagnostic software will also assist the mechanic in tracking down problems. The mechanic will simply feed the data into the diagnostic program, which will analyse it and compare it to reference information in the scanner's memory. It will then tell what is in error and where to look (component or system).

On some vehicles, diagnostic programs are now being built into the ECM itself. The Chrysler 'Deluxe CDR' is the most sophisticated system manufactured in North America. It has built-in (software) diagnostics (engine sensor

voltage parameter data) to aid in tuning and troubleshooting.

Inside a scanner

What's inside a scanner? As in many electronic products, it can run from the simple to the sophisticated. The simple ones use an RS-232 receiver or UART chip to retrieve the data from the ECM, and simple hardware decoding/display circuitry to display the fault codes on a readout panel. These units don't have an RS-232 port to the outside world, but some also function as a voltmeter.

The sophisticated units have 'full blown' processors, and may provide 'snap-shot' or recording features. The 'snap-shot' feature allows logging an active data sequence without storage. This means if the scanner is powered down, all data is lost.

The recording feature allows data to be saved in solid state memory until you erase it. This provides greater flexibility and is the preferred choice.

The more sophisticated units have an RS-232 port for external data access (Fig.3), and generally offer many accessories such as modems, additional solid state memory, terminals, and software that allow interfacing to a PC or terminal. Matching PC software is available for graphing, more extensive diagnostics and storing/retrieval of information in a database.

Many of the sophisticated scanners use the modular or system concept. This allows one to purchase a 'bare bones' unit and expand it later, as the need arises and your finances allow.

Fault codes

At this stage the fault or trouble codes, their meanings and significance are not standardised; they vary by manufacturer and even from model to model. Trying to memorise them all is therefore futile.

Working with a particular vehicle, one will soon remember the critical sensor or circuit fault codes. It's the same as working on other electronic equipment — once you become familiar with a particular unit, you know where to look. Certain circuits fail or act up more often than others, and you soon learn by symptom where to look.

Unfortunately car manufacturers treat fault code meanings in much the same way that they treat sensors. Just as different companies use different names like 'throttle position sensor' (TPS) and 'throttle angle sensor' (TAS) for the same device, so with fault codes we can find different meanings for terms like hard, soft, fault, trouble, maintenance, slow, fast, on-demand, continuous, KAM (keep alive memory), history, past, etc. Generally you must work with the codes to understand the usage.

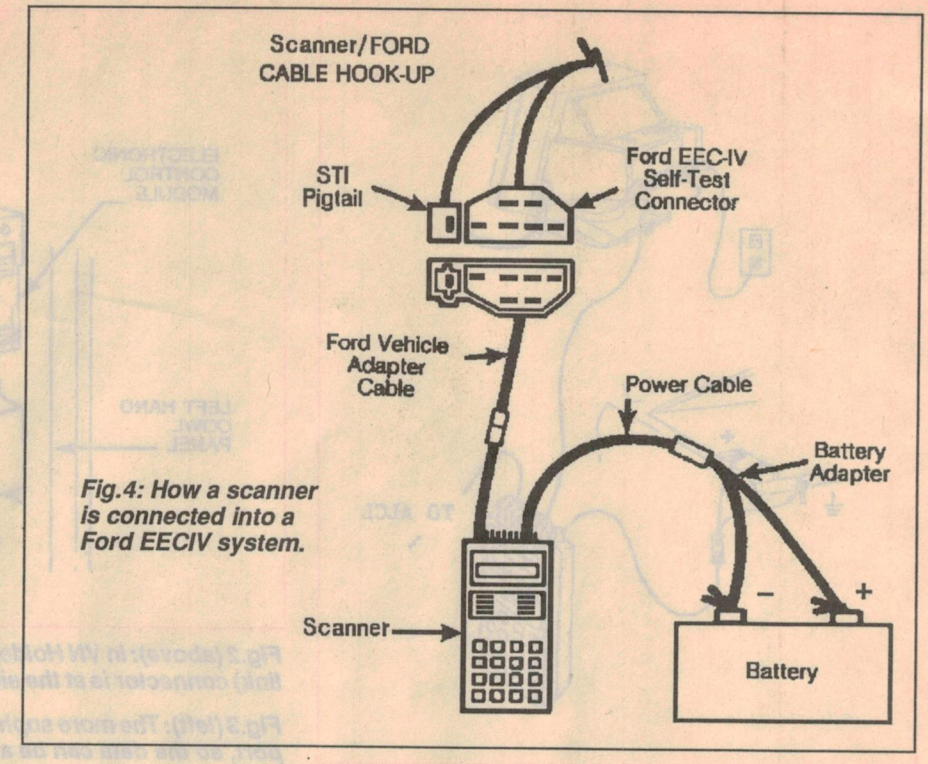


Fig.4: How a scanner is connected into a Ford EECIV system.

A scanner is not the only way to retrieve fault code data. A manual called *The Code Book* is available, which has all vehicle codes as well as other retrieval methods. Further information is available from the author, care of *EA*.

Incidentally the car's ECM system is often not the only source of diagnostic codes, in a modern vehicle. Some vehicles have more than one processor. There may be a separate processor for the anti-lock brake system (ABS), the cruise control, the transmission control system (CTS), the power control module (PCM) — and it goes on. Often different connectors are required for each system, making retrieval more difficult or costly.

A typical example

In Fig.4, the scanner is connected to a Ford EECIV system. This system provides self-diagnostics testing — a series of tests to aid in faultfinding. This system may have fault codes stored in KAM (really battery-backed or 'flash' RAM), indicating an intermittent or a past failure. If a particular test passes or fails, a code will so indicate.

Once the scanner is connected, it will request vehicle information. The information is then entered: Ford, year of manufacture and engine data. The scanner will then request what function or test is to be performed. On some scanners a menu will appear, like this:

1. Wiggle test
2. KOEO test (key on, engine off)
3. Computed timing check
4. KOER test (key on, engine running)
5. Clear memory
6. Output state test
7. Code library
8. Switch test

When the selected menu code is entered, the scanner display then directs the user on the correct sequence. At the completion of a test the scanner automatically goes to the code library, and the scanner indicates:

Review codes
Press: 1 - Codes
2 - Codes/Description
3 - Exit

The user selects his choice by entering 1, 2 or 3. For example if you enter '2' the display may indicate:

'26: MAF out of range'

(the MAF is the mass air flow sensor)

We'll look at the meanings of the fault codes next month, when we'll also discuss serial (active) data and the features provided in different scanners. We'll also look at the present and future requirements for a scanner.

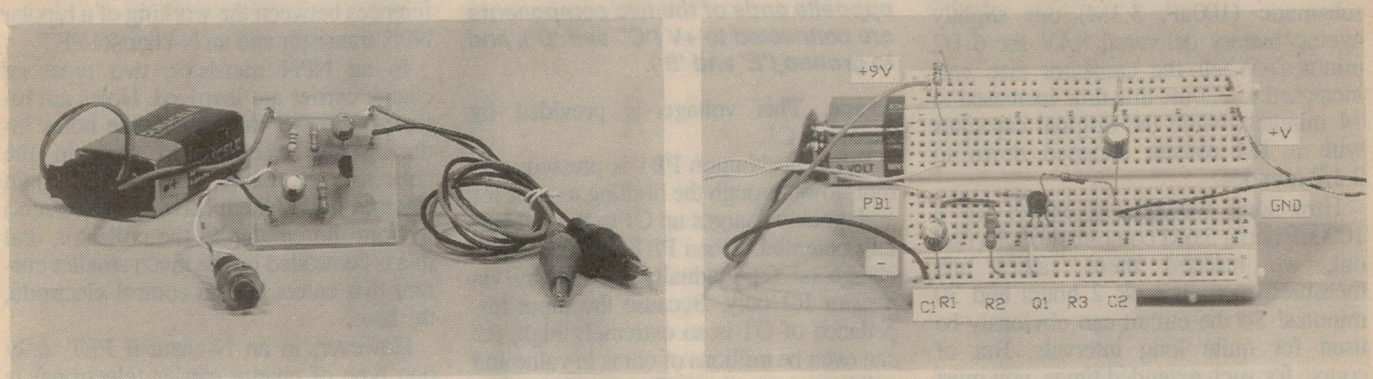
In the meantime, if you need further information on scanners, I suggest that you call Neville on (02) 708 3360. ❖

Experimenting with Electronics

by PETER MURTAGH

A simple battery saver

Battery-driven circuits can quickly flatten your battery, especially when you forget to turn them off! Not to worry. Attach our simple 'battery saver', and about six minutes after pressing the pushbutton it will automatically shut down the main circuit. To extend the time, just re-press the button and re-charge its 'memory'.



The photo shows how few components are needed for our auto power-off circuit. The power remains on for about six minutes after button PB1 is pressed.

Our circuits in this series have been steadily getting more complicated, so we thought it was time to produce a really simple one. At the same time we had a request from a grandfather who builds our circuits for his grandchildren. He wanted to cut down on having often to replace accidentally flattened batteries — we all know how easy it is to forget to switch off! Hence, this month's design.

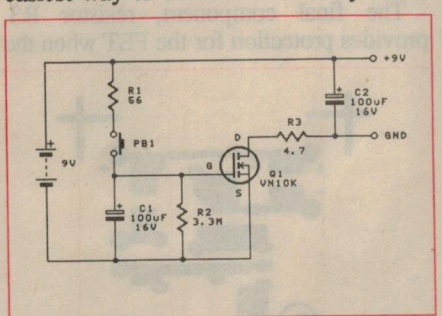
For a practical 'auto power-off' function, we need a circuit which will need negligible current in its standby mode and which can easily be kept switched fully on for intervals measured at least in minutes. Such a circuit can be built around a component called a FET (Field Effect Transistor).

Unlike normal bipolar transistors in which the load current is controlled by the base *current*, FETs control the load current by their gate *voltage*. (More about this later, in the 'Some theory' section.) This method of control means that FETs have an input impedance of around 10 billion (10^{10}) ohms, instead of around the normal 2-3k for bipolars. So the driving circuit of a FET has only to supply *negligible* current — which lets us satisfy the two main requirements for our battery saver.

So, press pushbutton PB1 and charge up capacitor C1. This keeps the FET Q1 switched on for around six minutes, during which time close to the full 9V is consistently supplied to the main circuit. After switch-off, the total current drawn from the battery is so minute that it measures only a few microamps.

Construction

A 9V battery snap is obviously the easiest way to connect the battery to the circuit, and we opted for two leads with alligator clips for the output. These leads were connected to the board via PCB pins.



The charge stored in capacitor C1 keeps the MOSFET Q1 turned on. Because Q1 is voltage-controlled (rather than current-controlled), Q1 discharges only through resistor R2. Hence a large discharge time-constant is possible.

Solder the resistors, capacitors and FET. Refer to Fig.3 for the polarity of the two capacitors (electrolytics) and to identify the pins of the FET.

Unfortunately, the pin order on the VN10K (SGD) is the exact opposite to that on a BC548 (CBE). In the top diagram of Fig.3, it is the *left* hand pin (C) of the BC548 which connects to the positive rail, but the *right* hand pin (D) of the VN10K. Similarly, the *right* hand pin (E) of the NPN and the *left* hand pin (S) of the FET connect to ground.

Note that FET names refer to 'electron' flow — not conventional 'current' flow. That's why the drain (D) connects to the positive rail, and the source (S) to ground. Once you realise this, you can think of an N-channel FET as operating similarly to an NPN bipolar transistor, with the drain, gate and source corresponding to the collector, base and emitter.

With the FET pins sorted out, connect the pushbutton, the battery snap and the output leads. It is probably worth mounting the circuit more permanently in a box — this will make it more convenient to

power up any other projects that you wish to use. And because the VN10K is rated at 0.8A, the battery saver can be used with many other projects, as well as those from the 'Experimenting' series.

Changes

If you want to alter the time that the battery saver delivers full voltage, simply change the values of capacitor C1 and/or resistor R2. These determine the time constant (which will be further explained later in 'Some theory'). We tried several combinations:

With the values shown on the schematic (100uF, 3.3M) our slightly ageing battery delivered 8.4V for 6-1/2 minutes. When the capacitor size was increased to 220uF, this time increased to 14 minutes; while the original capacitor with a 1M resistor dropped down to 2-1/2 minutes.

How long would you expect for a 1000uF and a 5.6M combination? To find out, we inserted these values and measured it — it took 2 hours and 30 minutes! So the circuit can obviously be used for quite long intervals. But of course for such extended times, you must allow longer for the circuit to shut down. Once the voltage started to drop after the 150 minutes, it took another *15 minutes* before the load current had dropped to 500uA. Compare this with the one minute it took the original circuit to effectively switch off.

How it works

The main role of FET Q1 is to act as a switch, to connect the output ground to the battery negative. To do this, a voltage must be applied between its gate and source. This voltage is provided by capacitor C1.

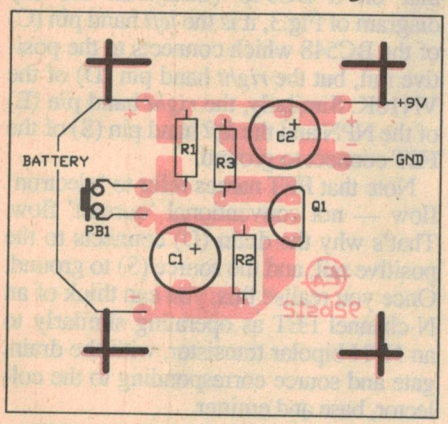


Fig.1: The component layout for the PCB. This simple circuit has only three polarised components — the two electrolytic capacitors and the MOSFET.

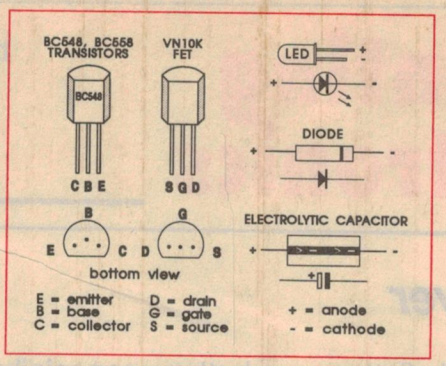
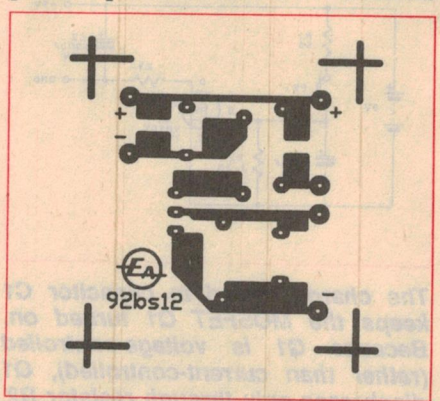


Fig.3: The component leads identification diagram for the polarised components used in the circuit. Note the reversed order of the leads on the BC548 and VN10K — the pins at opposite ends of the two components are connected to +V ('C' and 'D'), and to ground ('E' and 'S').

When pushbutton PB1 is pressed, current flows through the limiting resistor R1 and quickly charges up C1 to the full battery potential. When PB1 is released, the charge on C1 gradually leaks away via resistor R2 only. Because the input impedance of Q1 is so extremely high, R2 can even be millions of ohms in value and still be very much smaller than Q1's gate-source resistance. So we can ignore Q1 when calculating the time constant for the discharging of C1.

The second capacitor C2 is included in the circuit to reduce the output impedance of the battery, which is made even more desirable because of the presence of the series resistor R3. The capacitor smoothes the output, by acting as a reservoir to top up brief high-current demands. The battery can only deliver quite a small steady or average current, but by placing the capacitor in parallel, it becomes capable of supplying quite large — though brief — pulses.

The final component, resistor R3, provides protection for the FET when the circuit is first turned on. If the load circuit has bypass capacitors (like C2), these will provide an effective shortcircuit until they charge up. The 4.7 ohm value of R3 has been chosen to limit the startup current to about 2A (at 9V), which is the pulsed current rating for the VN10K FET.



The PCB pattern is shown actual size to allow you to etch your own board.

Any other FET can replace the one we used, provided that it is an N-channel, enhancement mode power FET. Ours was chosen simply because it was the cheapest we could find. (In fact, DSE sold us a VN0106, which is an equivalent of the VN10K.)

Some theory

First of all, a little more about the differences between the working of a bipolar NPN transistor and an N-channel FET.

In an NPN transistor, two types of charge carrier are involved. Holes are injected into the base, and these holes induce many electrons to flow in the collector (or load) circuit. The main electron flow (which is really the current) is from the emitter to the collector, and this is controlled by the much smaller current that enters by the control electrode, the base.

However, in an N-channel FET, only one type of charge carrier (electrons) is involved. The electron flow is from source to drain, along a channel of N-type material. This channel is sandwiched between two P-regions which form the gate, and can be used to alter the depletion layer and 'pinch off' the current. It is actually an electric field applied between the gate and the source that controls the load current.

If you use a reverse-biased N-channel FET (a JFET), you actually have to make the gate more negative than the source, to pinch off the main current. This means that without any gate bias the FET

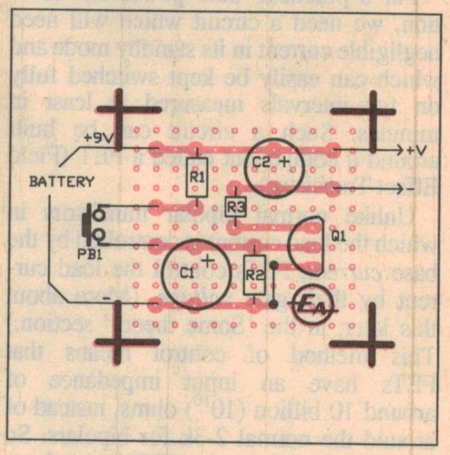


Fig.2: The stripboard layout. Since all resistors are shown as smaller than 0.4", it is easier to mount these components vertically.

remains on. But with the enhancement mode MOSFET that we have used, a positive gate voltage is required to turn the transistor on.

Now for our second bit of theory — time constants. A capacitive time constant is the time it takes a capacitor to charge up via a resistor to 63% of its total potential, or discharge to 37% of its starting potential. Because C1 charges up very rapidly via the 56-ohm resistor R1, we will consider only its slower discharge via R2.

If you were wondering where the above percentages come from, remember that capacitor C1 discharges exponentially. And the value of e^{-1}=0.37! In practical terms, an exponential discharge means that the capacitor's stored charge decreases very quickly to start with, but this drop-off rate becomes continually slower as the discharge continues. After one time constant, the remaining charge is down to 37% of the original value.

To calculate the numerical value of a time constant (in seconds), simply multiply the value of the capacitor (in Farads) by the value of the resistor (in ohms). Use the values shown on the schematic, and you will find that this give a time constant of 5m 30s.

Measurements made on our circuit showed that the capacitor had to drop from its original 8.2V down to 2.0V before the FET started noticeably to turn off. This means that the capacitor had to discharge to 24.4% of its original voltage, which is more than one time constant. By calculating the natural log of 8.2V/2.0V, we find that it is actually 1.4 time constants — ln 4.1=1.4.

Calculate the theoretical times for the various R/C combinations, and compare them with the actual measured times (in brackets):

220uF/3.3M 16m56s (14m)
100uF/3.3M 7m42s (6m30s)
100uF/1.0M 2m20s (2m30s)

PARTS LIST

Miscellaneous

PCB 38x36mm, coded 92bs12
9V battery
9V battery snap
2 alligator clips
hookup wire, solder, etc.

Resistors

All 1/4W, 5%
1 56 ohm R1 green-blue-black
2 3.3M R2 orange-orange-green
1 4.7 ohm R3 yellow-purple-gold

PC-mount electrolytics

2 100uF, 16V C1,C2

Semiconductors

1 VN10K N-channel FET Q1

Because of the high input impedance of the FET the two columns of results are very close. We can blame the difference on the leakage from the electrolytic capacitors. This shortens the longer time intervals, especially with larger capacitor values.

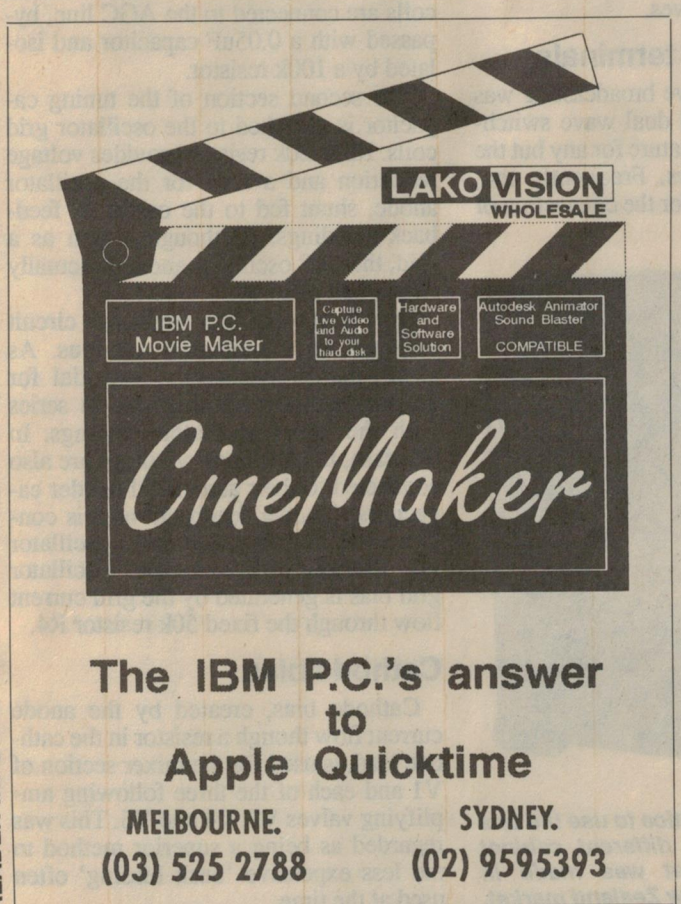
Why not do the calculations for our very extended timeout? — remember that our measured time for a 1000uF capacitor and a 5.6M resistor was 2-1/2 hours. Check that the theoretical time for the capacitor to drop from 9.0V to 2.0V is 2h20m23s, or 1.5 time constants.

I hope you have found this extra bit of theory interesting. Normally the editor doesn't give me enough space to diverge like this!

Transparencies

As usual, a high contrast, actual size transparency (negative) for the PCB used in this circuit is available for only $2. This will allow you to etch your own printed circuit board. This special price applies for transparencies for all projects in this series only. Write to *EA*'s reader services division.

Happy experimenting — and please send us your comments on the circuits we have published, as well as ideas for future projects. ❖



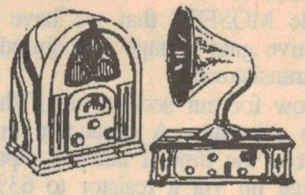
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READER INFO NO. 22

Vintage Radio

by PETER LANKSHEAR



An Australian receiver with metal valves

Last month's column covered the evolution of the first generation of American metal octal valves, released with much fanfare in mid-1935. Some Australian receiver manufacturers were quick to use the new valves and this month we study one of these chassis, the STC model 68.

In the 25 or so years since the manufacture of valve radios gave way to semiconductors, electronics technology has undergone radical changes, a major factor being the reduced cost of amplification. Valves had a high labour content in their manufacture, and their associated circuits were component based, factors which made receivers relatively expensive. One additional valve had a considerable influence on a radio's price.

In contrast, today's receivers can be considered more as systems, assembled largely from IC modules. The addition of a few extra transistors or an IC or two is of little consequence and peripherals such as memories, scanners and readouts — features never dreamed of in valve radio design — can be more complex than the basic receiver they are serving.

Although valve receivers are relatively uncomplicated, they nevertheless require a degree of specialist knowledge and the newcomer, although he may be well versed in electronics, can find vintage technology unfamiliar. As one object of this column is to take some of the mystery out of valve radios, the STC 68 circuit will be described stage by stage, and hopefully the analysis will give some insight as to why some things were done the way they were.

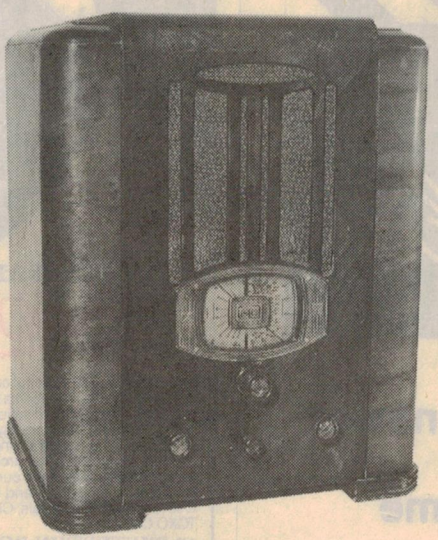
This chassis is a member of what became by far the biggest class of valve receiver, and the equivalent can still be found in today's inexpensive pocket receivers. This is of course the classic '4/5 valve' superheterodyne, comprising a frequency converter, intermediate frequency amplifier, detector and AGC diodes, and a two-stage audio amplifier — plus the usual rectifier.

Yes, I know that the STC 68 actually has *six* valves. But as explained last month, until the metal series combined diode and amplifier valves appeared early in 1936, the detector and first audio stage pair required two valves. Essentially it was still the ubiquitous 'five valver', in a functional sense.

Contrary to some of the contemporary advertising hyperbole, metal valves required no special technology or circuits. Electrically they were interchangeable with their glass predecessors, as comparison with the circuit of the earlier model 50 will show. Even resistor values in most positions were identical. By using an existing design, STC would have been able to commence production of the 68 chassis with a minimum of delay, and were no doubt at an advantage by their being at that time the Australian distributors of Raytheon valves.

Dual wave, PU terminals

By 1935, shortwave broadcasting was well established and dual wave switching was a common feature for any but the most basic receivers. Frequently too, there was provision for the connection of a gramophone pickup — although in many households, just how often recordings were actually played is debateable.



It was common practice to use the one chassis in several different cabinet styles. This cabinet was made in Auckland for the New Zealand market.

Referring to the diagram, the aerial terminal is connected by the three-position wavechange switch to the primary winding of the selected aerial coil. The upper switch position is for shortwave, the centre position for general broadcast and the lower for local station listening. The secondary winding of the selected coil is tuned by the first section of tuning capacitor C1, as well as being connected to the signal grid of 6A8 converter valve V1. The low potential ends of the tuned coils are connected to the AGC line, bypassed with a 0.05uF capacitor and isolated by a 100k resistor.

The second section of the tuning capacitor is switched to the oscillator grid coils. R5, a 20k resistor provides voltage reduction and a load for the oscillator anode, shunt fed to the oscillator feedback windings. (Although drawn as a grid, the 6A8 oscillator anode is actually only a pair of rods).

One feature of the oscillator circuit may not be immediately obvious. As usual, padder capacitors, essential for proper oscillator tracking, are in series with the tuned oscillator windings. In this case, the feedback windings are also connected to their associated padder capacitors. 'Padder feedback' as this configuration is called, improves oscillator low frequency performance. Oscillator grid bias is generated by the grid current flow through the fixed 50k resistor R4.

Cathode bias

Cathode bias, created by the anode current flow though a resistor in the cathode lead, is used for the mixer section of V1 and each of the three following amplifying valves V2, V4 and V5. This was regarded as being a superior method to the less expensive 'back biasing' often used at the time.

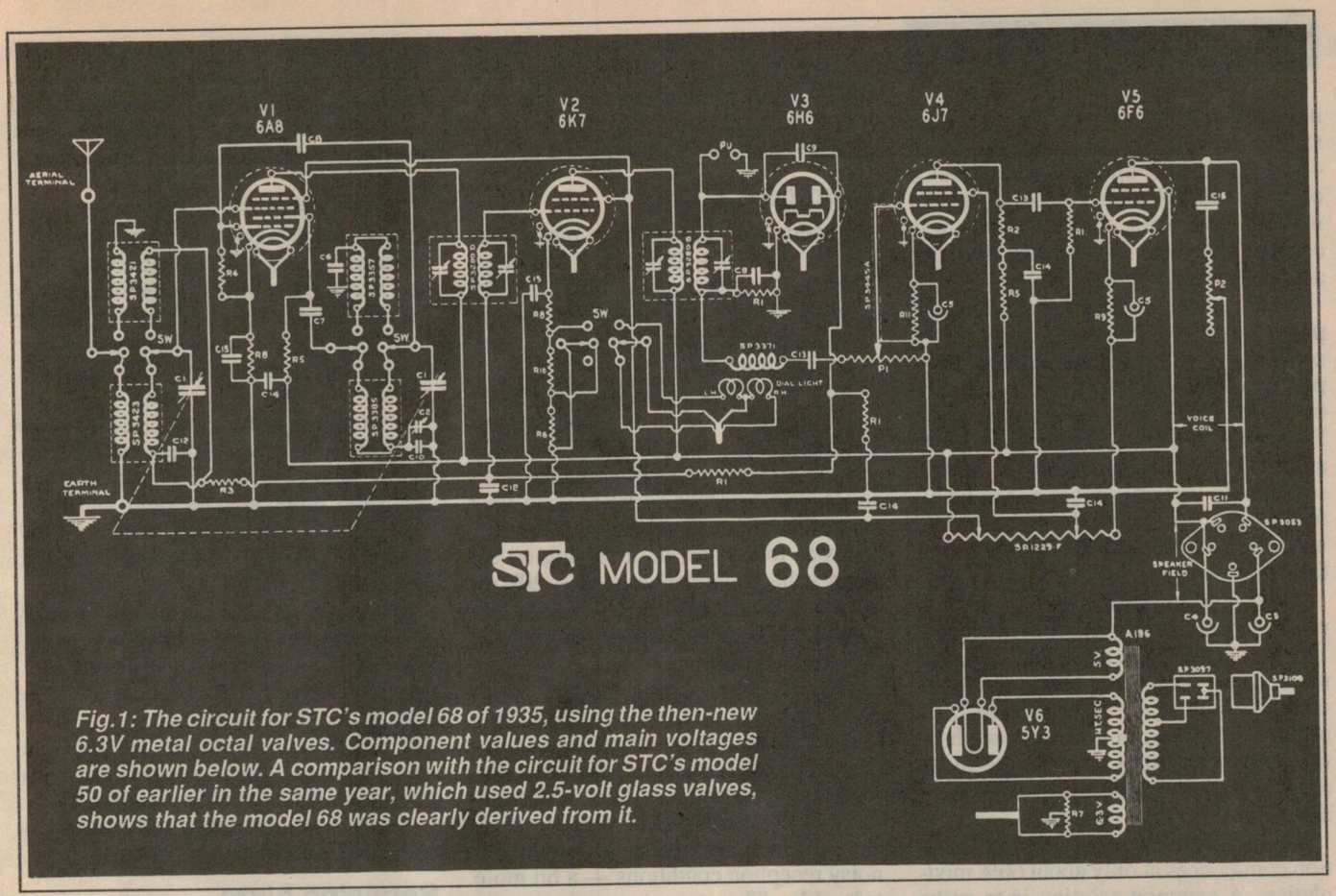


Fig.1: The circuit for STC's model 68 of 1935, using the then-new 6.3V metal octal valves. Component values and main voltages are shown below. A comparison with the circuit for STC's model 50 of earlier in the same year, which used 2.5-volt glass valves, shows that the model 68 was clearly derived from it.

A 6K7 variable-mu RF pentode is used for the intermediate frequency amplifier, operating at 450kHz, and is coupled to the converter by a double-tuned IF transformer. One segment of the wavechange switch controls resistors in the 6K7 cathode bias circuit. In the shortwave position, the two lower resistors are shorted out and the IF stage operates at maximum gain. During broadcast reception, with its greater signal strengths, an additional 1200 ohms is added to reduce gain. For quieter operation in strong signal or noisy areas, a 10k third resistor is switched in, further reducing gain.

Another switch segment selects the dial lamp illuminating the appropriate tuning scale. The 6A8 and 6K7 screen grids operate at about 100 volts positive, and STC practice was to derive this from adjustable tappings on a large HT 'voltage divider' resistor.

Detection and AGC voltage are provided by the 6H6 double diode, operating with the detector load of a 0.5M resistor and a 100pF capacitor connected between the lower end of the second IF transformer secondary and the earthed cathode. The audio signal is coupled to the volume control via an RF choke and 0.01uF capacitor.

The use of an RF choke for keeping IF voltages out of the audio amplifier was

THE FOLLOWING VOLTAGES ARE TO BE SET WHEN THE TRANSFORMER IS CONNECTED TO 240 VOLTS 50 ~ THROUGH THE 240 V TAPPING ON THE TRANSFMR.

ALL READINGS TO BE TAKEN WITH 1000Ω P/VOLT VOLTMETER VOLUME CONTROL SET AT MAXIMUM.

V1. 6A8.	
SCREEN GRID	90V.
OSC. PLATE.	260V.
PLATE	185 V.
BIAS	1.2 V
FILAMENT	6.2V
V2. 6K7	
SCREEN GRID	90V
PLATE	260V.
BIAS	4.6V
FILAMENT.	6.2V
V3. 6H6.	
V4. 6J7.	
SCREEN GRID.	90V
PLATE.	40V
BIAS.	.6V
FILAMENT.	6.2 V.
V5. 6F6.	
SCREEN GRID.	260V.
PLATE.	235V.
BIAS	16V.
FILAMENT.	6.2 V.
V6. 5Y3	
RECTIFIER AC.	400V
RECTIFIER DC.	400V
FILAMENT.	5 V.

Component values for the STC model 68, along with the main circuit voltages.

STC MODEL 68

S.P.Nº	CODE	NAME	S.P.Nº	CODE	NAME	S.P.Nº	CODE	NAME
3366	C1	2 GANG COND & DIAL ASS'Y		R3	100,000Ω RESISTOR	3280-B		I.F. TRANSFORMER ASS'Y
3082	C2	PADDER CONDENSER		R4	50,000Ω "	" -D		" " "
	C3	8μF ELECTROLYTIC COND.		R5	20,000Ω "	3371		R.F. CHOKE.
	C4	16μF " "		R6	10,000Ω "	1229-F		16,000Ω POT. DIVIDER.
	C5	25μF " "	3103-S	R7	100Ω CT. "	3086-A	P1	500,000Ω POT.
	C6	.0039— .0041μF MICA COND.	" F	R8	110Ω "	" -E	P2	50,000Ω "
	C7	.001 μF " "	" -B	R9	400Ω "			DIAL LIGHT LEAD ASS'Y.
	C8	.0001 μF " "	" -P	R10	1,200Ω "	3105.		P.U. PLATE.
	C9	.0002μF " "	" -T	R11	600Ω "	3053.		SPEAKER SOCKET.
	C10	.00029— .00031 μF " "		R12			SW.	YAXLEY SWITCH PLATE.
	C11	.006 μF PAPER COND.						
	C12	.05 μF " "						
	C13	.01 μF " "	A.196		POWER TRANSFORMER			
	C14	.5 μF " "	3106		POWER LEAD ASS'Y.			
	C15	.1 μF " "	3097		TERMINAL PLATE.			
			3423		M.W. AERIAL COIL ASS'Y			
			3385		M.W. OSC. " "			
			3421		S.W. AERIAL " "			
	R1	500,000Ω RESISTOR.	3357		S.W. OSC. " "			
	R2	200,000Ω "	3445-A		SHIELDED GRID LEAD.			

not common. In fact it is hard to understand why a choke was used at all; at 450kHz, a 10mH choke has a reactance of less than 30k ohms. Most designers instead used a 50k resistor, which was cheaper and more reliable, and the extra attenuation is negligible.

There is no switching for gramophone pickup operation. Instead, a couple of sockets are provided for connecting a pickup directly across the volume control, and incidentally, the detector diode. Presumably the magnetic pickups in use at the time were considered to have a sufficiently low impedance not to be affected by a parallel diode — but would need to be unplugged for normal reception, of course.

With modern transmissions having modulation percentages often exceeding 100% in the positive direction, the original detector design has shortcomings in common with many older receivers. To achieve low distortion at high modulation levels, the ratio between the diode load and the following grid resistor should be as high as possible.

With STC's unity ratio, serious distortion commences at only about 60% modulation. A common solution is to make the volume control the diode load. At normal listening levels, the grid resistor is in effect tapped well down the load, making the ratio much higher and distortion is improved.

The catch is that volume adjustment will generate noise if the volume control is not of very good quality.

Undelayed automatic gain control voltage is generated by the second 6H6 diode. Delay could easily have been provided by connecting the cathode of the AGC diode to the cathode of the 6J7.

High gain audio

In common with the great majority of similar receivers, there is a two stage resistance-coupled audio amplifier. The combination of 6J7 and 6F6 pentode valves provides plenty of gain and several watts output.

A series resistor, typically of about 1M ohm, was used by many manufacturers to supply the correct voltage to the screen grid of resistance-coupled pentodes. These carbon resistors were very prone to increase in value, and STC practice was to use instead a tapping on the main voltage divider resistor. A 20k resistor bypassed with a 0.5uF capacitor provides additional hum filtering for the 6J7 anode supply.

The 6F6 output stage is standard, with a 50k pot and a 0.1uF capacitor 'tone control'. Similar tone controls were to be found on many receivers, and made listening to the combination of a pentode valve and a loudspeaker whose impedance rose with frequency — often with noisy reception conditions — a bit more tolerable. The output transformer is mounted on the electromagnetic field loudspeaker and the two are connected to the chassis by a plug and standard 5-pin valve socket.

Another socket is provided for the mains supply lead and incorporates 220/240V voltage selection by the position of the plug. The power supply is quite standard, with a centre-tapped HT winding connected to the anodes of a 5Y3 rectifier. As explained last month, the 5Z4 of the original metal valve series was unreliable and the glass 5Y3 quickly took over.

The rectified HT energises the loudspeaker field magnet winding. One advantage of the EM (electromagnetic) speaker was the ability of the field winding to substitute for a filter choke for hum filtering; but to obtain the necessary number of ampere-turns, the field was wound with a lot of fine wire.

Australian receivers frequently used speakers with fields of 2500 ohms resistance. With 60mA of HT current, there was 150V dropped in the field, and associated power transformers were required to supply 380 - 400 volts to each rectifier plate.

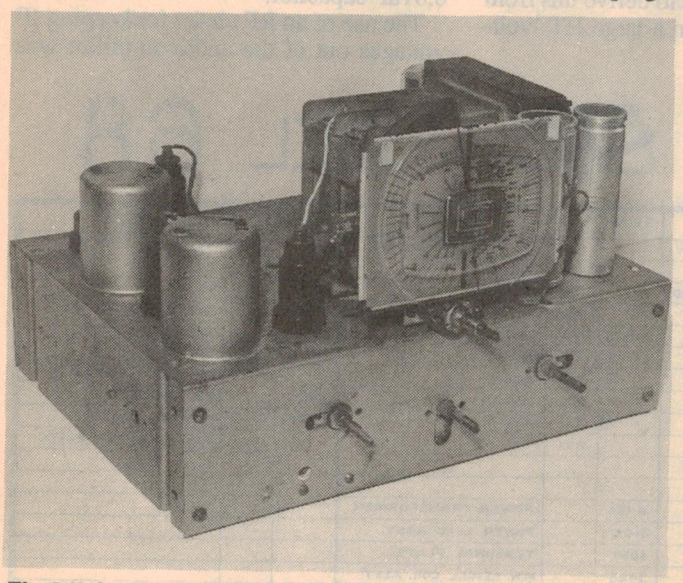
Obviously then, with mains voltage and that order of HT voltages present, work on live chassis should be done with care. The old rule of keeping one hand in a pocket is still a good one!

STC receivers are easy to work on, and so are a good introduction to valve radio servicing. Their spacious chassis and extensive use of tagboards assist in location and identification of components.

Servicing hints

First check the power cable and plugs and if there is the slightest doubt, renew the cable and check too that the connections are to the correct terminals. Some nasty shocks have resulted from the active lead being inadvertently connected to the chassis.

STC used reliable resistors, and unless



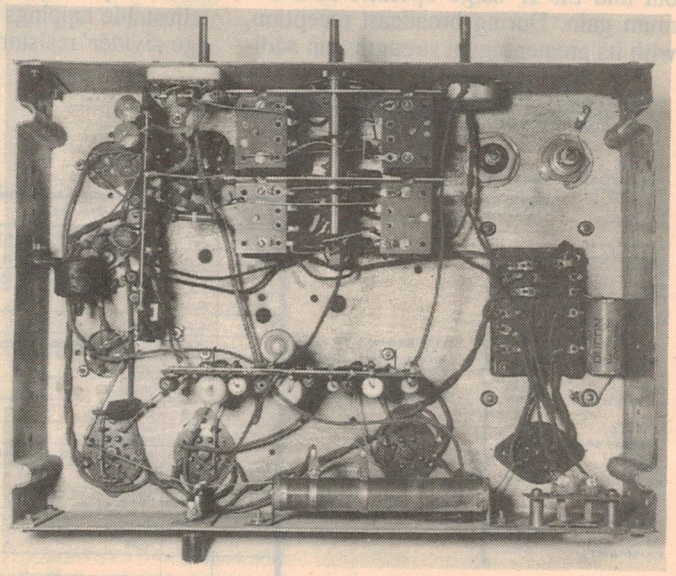


Fig.2 (left): The relatively small size of the metal valves and lack of shields gave the large chassis an uncluttered appearance. In a modern restoration the original wet electrolytic capacitors can be left for appearance, but should be disconnected and functionally replaced by modern components. Fig.3 (right): Component mounting boards and a roomy chassis make STC receivers ideal for the vintage radio novice to work on.

there has been an accidental overload, few are likely to need attention. Their cathode resistors were quite distinctive and wire wound on fibre forms.

Another STC specialty was the main voltage divider, a fibre cylinder wound with fine resistance wire and with adjustable tapping clips. Normally there should be no need to alter the clip settings and as the wire is very fine and easily damaged, it is unwise to touch them. An open-circuited section can be replaced by connecting the clips on either side with a 5W resistor whose value can be easily calculated. The total resistance of the divider is 16k and the resistance of any section is proportional to its length. Thus if the distance between two tappings is 1/5 the total, a suitable bridging resistor would be 3.3k.

The paper capacitors may not have lasted well. After more than half a century, moisture is likely to have penetrated their seals to the detriment of the insulation resistance. This is not too important in the case of the 6A8 and 6K8 cathode bypass and the voltage divider tapping bypass capacitors, but the remaining paper capacitors should be checked carefully and replaced if their resistance is lower than about 50 megohms.

As any leakage in the 0.01uF capacitor coupling the anode of the 6J7 to the control grid of the 6F6 is very serious, it should be replaced regardless. Suitable modern capacitors are polyesters or polycarbonates. For HT bypassing and the 6J7 anode coupling capacitor, use 630VW polyesters.

The original electrolytic capacitors will have long since dried up. Modern 22uF/25VW types are suitable as replacements for the 6J7 and 6F6 cathode bypass capacitors, but there are traps in replacing the HT filter capacitors. Originally these were wet electrolytics — literally, in tall liquid-filled aluminium cans. Replacements can be standard dry types, but as peak HT voltages — especially during warmup of the indirectly heated valves — can be very high, replacement input filters should have a peak rating of at least 525 volts. These are now hard to find, and it may be necessary to use a pair of equal capacitance 350-volt capacitors in series. Bridge each capacitor with a 270k 1W resistor, to equalise leakage currents and balance their voltage drops.

Another point to watch is that the value of the input filter capacitors is not too great, or rectifier damage and excess voltage may result. This is not so important for the output filter, but for the input, a pair of series-connected 33uF capacitors should be the maximum value.

Collector's Corner

Where readers display prized items of radios and other equipment from their collections, and/or seek information from other collectors...

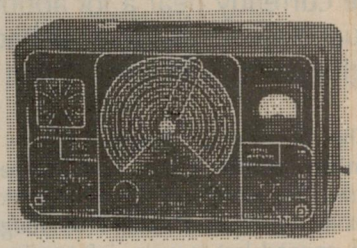
AK paint colours

I am currently attempting to restore an Atwater Kent battery wireless model 48, and also a model 49, both of 1928 vintage. I wish to know the correct colour match for the original rich brown used on the metal front panel and the audio transformers.

I'm a little confused in this area, because Peter Lankshear's article some time ago on the model 20C comments on the front panel being a grey/brown fine wrinkle finish. I have a model 20C in reasonable condition, and allowing for colour fade by inspecting the paint behind the gold-plated 'AK' badge, mine is more of a rich brown — with not much, if any hint of grey.

I would also like to know the tone of brown used on another set that I have, an AK 43 model which is an early AC set of 1928 vintage in an all-metal box. Did Atwater Kent use different browns on different wireless sets of this era? I would also like more information regarding the stain toning of the mahogany cabinet of the 20C, 48 and 49. If anyone can help me with this information, or a contact in America who can, I'd be very grateful. **(C.T., Gulnare, SA)**

Circuit wanted



I have acquired this Triplett model 1632 RF signal generator, which I'd like to restore to its original condition. Can anyone provide me with a photocopy of the circuit? I'd be most grateful. **(A.P., Cronulla, NSW)**

Mechanical problems

STC dial drives of the mid-1930's used a dual-speed planetary system assembly, mounted on the tuning capacitor frame and driving the edge of a semicircular brass disk by means of the grip of a pair of small friction wheels. Unfortunately the edge of the disk is likely to have worn, causing slipping.

If the wear is too great, the only remedy is to cut a new disc from sheet brass. Gentle peening of the hollow rivet holding the two friction wheels may tighten the drive sufficiently to cure slipping.

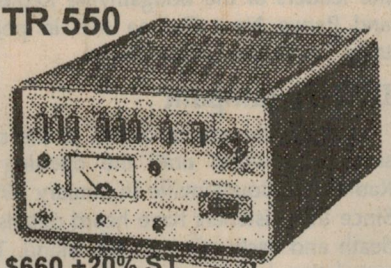
The volume control may be a bit scratchy. This can come from dust and dirt on the carbon track, and a squirt from a contact cleaner aerosol spray may cure the problem. Often the spray can be directed through the terminal openings. If this fails, wear is the problem and a new control will be needed.

Finally, replacement metal valves may be hard to come by, but there are glass equivalents for all types — although for the IF stage a 6K7G may be unstable without a shield. This is not likely to be a problem with a 6K7GT. ❖

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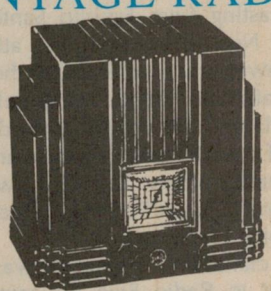
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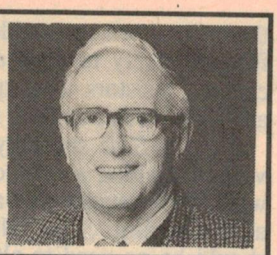
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READER INFO NO. 24

SHORTWAVE LISTENING

by Arthur Cushen, MBE



Distressing news from Radio Free Bougainville

We currently hear a lot about the appalling conditions in the African country of Somalia, but a similar situation is occurring at our back door in the South Pacific. Daily transmissions from Radio Free Bougainville highlight the problems in that part of the Northern Solomons.

The position of Bougainville in the Northern Solomons has been desperate for months, as Papua New Guinea blockades the area. Since Radio Free Bougainville opened last January, information on the plight of the inhabitants has been received on its daily transmissions.

Radio Free Bougainville was officially opened by the Prime Minister of the Republic of Bougainville on January 31st, 1992, though it actually commenced operation on January 25th on 3890kHz, using a transmitter supplied by the International Amateur Radio Network. A recent frequency change to 3870kHz has resulted in an increased signal. At 1000UTC, there is a 20-minute news bulletin in Pidgin, followed by recorded music, while at 1100 there are further announcements, including some in English, as well as references to the 'Republic of Bougainville' and 'Independent Bougainville'.

It is only 10 years ago that a similar situation in the South Pacific sought to gain freedom for its inhabitants — Radio Venerama in 1982, broadcasting from Espirito Santo in the former New Hebrides. That attempt to break away was short lived, as the powers of Britain and France were called into Port Vila and the British jammed the station off the air. Later, spokesman for the movement, Jimmy Stephens, was captured and jailed at Port Vila, which is now the capital of Vanuatu.

This clandestine operation was a little different to Radio Free Bougainville, in that it had the backing of foreigners who sought to control the major resources on Espirito Santo.

The co-dominion of France and Britain ended in the New Hebrides with the formation of the Republic of Vanuatu.

Radio Bougainville however, is reporting not a propaganda message but one of the stark reality of life on the Island. Schools, churches and other oganisations are using the station for notices and information, on an island starved of media information. The operation also covers Government statements and the local hope that the world will recognise Bougainville as a republic.

The history of Bougainville has an unusual twist as it had previously been part of the Solomon Islands, before World War II.

After the war Bougainville became part of the Australian Trust Territory of Papua New Guinea. When Papua New Guinea gained its independence, it also claimed Bougainville as part of its territory.

The seccession movement started in May 1989 when the enormous open-cut copper mine at Panguna was shut down after repeated attacks on personnel, vehicles and machinery by militant landowners led by Francis Ona, now head of the interim Government. In May 1990, the Bougainville Revolutionary Army unilaterally declared independence, and Papua New Guinea imposed a blockade around the island.

Australia and New Zealand have jointly attempted to quell the uprising and in 1990, three New Zealand war ships were located off the coast of Bougainville and the leaders of the Bougainville Republic and Papua New Guinea met in peace talks. These were unsuccessful.

Disease rampant

Bougainville was unknown to the outside radio world until the opening of Radio Free Bougainville in January 1992. Since then listeners have heard details of death and destruction on the island. The population is living in poverty, common medical assistance — even soap — is not available, babies die at birth and reports indicate that the hospital has neither light nor water. Vaccination of children is unheard of, because since 1989 the refrigeration and storage of vaccines has not been possible.

The main supply line into Bougainville, which brings the oil necessary to power the Bougainville transmitter, comes from the Solomon Islands. Last year, some medical supplies were also reaching Bougainville through this route, across a virtually open border to Southern Bougainville. However, a Papua New Guinea raid in March destroyed a fuel dump on Shortland Island, and in recent months harrassment of the Bougainville population is said to have increased.

Communication award

The latest issue of 'Target', the magazine of Radio Nederland which is issued every six months free to a mailing list of around 35,000, gives details of the award to Media Network won at the International Radio Festival of New York.

Johnathan Marks hosts this weekly survey of communications developments, compiled with the assistance of over 190 monitors across the globe. Regular contributions to the programme come from New Zealand, Sri Lanka, United States, Holland and Russia. The programme offers unrivalled coverage of media developments linked to current events, as well as full-length documentaries. Broadcasts of Media Network are on Thursdays, 0750 on 9630 and 11,895kHz and repeated at 0950 on 9720 and 11,895kHz.

Communications are playing a large part in education, particularly in media studies, and there are many schools throughout the world which feature shortwave listening as part of this subject. Recently on RNZI from Wellington, a visiting Canadian teacher spoke in glowing terms of her move to include shortwave listening in media studies. The idea was so successful that she plans to make it a standard practice in the future.

AROUND THE WORLD

ALBANIA: Trans World Radio is now using a one million watt transmitter at Tirana, Albania to carry programmes in East European languages for three hours a day, 2000 - 2300 on 1395kHz. There has been a remarkable change of message from Radio Albania — the station has been heard stating that, "We are pleased that you have tuned to Radio Tirana. We have had a severe communist rule for some 50 years, and to make major changes will be difficult. But this is an irreversible process."

CHINA: Radio Beijing is now known as Radio China International, and its transmissions to the South Pacific are: 0900 - 1000, 1000 - 1100 on 11,755, 15,440 and 17,710kHz; and 1200 - 1300 on 11,795 and 15,440kHz.

COSTA RICA: Spanish Foreign Radio in Madrid has set up a relay base in Costa Rica using three 100kW transmitters. All broadcasts are in Spanish and are beamed to Central and South America. Our reception has been on 5970kHz, with a time signal at 0430, then a 30 minute Spanish news, followed by a feature programme until closing at 0500. It is understood that other frequencies such as 15,110 and 17,845kHz have been used around 1300.

CZECHOSLOVAKIA: It is expected that the former Radio Prague — now known as Radio Czechoslovakia — will again change its name, with the two parts of the republic being separated. It now uses the slogan 'Radio Czech & Slovak'. Broadcasts in English have recently been heard on new frequencies, according to Media Network, and at 0400 it is using 11,985 and 13,715kHz.

LEBANON: The Voice of Lebanon has been operating for many years on 6550kHz and traditionally had news in English at 1815. This recently seems to have been cancelled, and replaced by a news bulletin in French. This is the only reliable signal from Lebanon, except for the King of Hope which broadcasts from Southern Lebanon.

LUXEMBOURG: Radio Luxembourg has gradually decreased its shortwave operation. The frequency of 5090kHz was closed some time ago, and that carried the German programme. At the end of December, the channel of 15,350kHz, which carries English, is to cease broadcasting in that language. Using a power of 10kW, the transmissions on 15,350kHz were widely reported, particularly in the South Pacific, around 0600. It is presumed that this frequency will now carry German programmes.

SWITZERLAND: The International Committee of the Red Cross in Geneva uses the facility of Swiss Radio International on the last Thursday of each month, to broadcast a feature programme for listeners in the Pacific. The transmissions are 0915 on 9560, 13,685, 17,670 and 21,770kHz, with a further broadcast at 1115 on 13,635, 15,505, 17,670 and 21,770kHz.

VENEZUELA: Radio Continente, Caracas, has returned to shortwave after many months of absence. It has been noted on 5030kHz, opening shortly after 0900 with a music programme. At 0930 it has the typical Spanish identification, then a network call in which many stations are listed. This is followed by a 30-minute feature of news and information. Broadcasts are easily recognised by the chime between each announcement.

Some of the students had shortwave radios at home but had never used them. The introduction broadened their horizons and taught them that there is a lot more to radio than just local AM or FM. One of the students had parents from Yugoslavia and was able to listen to Radio Yugoslavia.

The listening works well as a motivator, particularly in geography classes. When you are studying a particular country, and can listen to broadcasts from that area, it heightens the students' interest in that country. It also offers alternative English presentations from various stations throughout the world. So shortwave listening seems to be rapidly finding a new place in the classrooms of high schools in many parts of the world.

This item was contributed by Arthur Cushen, 212 Earn St. Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 11 hours behind Australian Eastern Daylight Time and 13 hours behind NZ Daylight Time.

Historic dates

1992 was a memorable year for broadcasting anniversaries. It was on October 4, 1922 — 70 years ago — that the first radio station outside North America commenced operation. This was in Dunedin, New Zealand, and was run by the Otago Radio Association. The station is still broadcasting today. Since deregulation of radio in New Zealand, it has become a fulltime commercial broadcaster, on the air 24 hours a day with the slogan 'Dunedin Radio 4XD, 1305kHz'.

The BBC commenced broadcasting in October 1932 in what was then the Empire Service. I can recall the first Christmas broadcast by King George V, on Christmas Day 1932. Listening in New Zealand at 3am on Boxing Day morning on a Philco receiver, the message was clearly heard from London.

Radio Australia commenced operation in December 1939, and has been broadcasting to the Pacific and Asia, now using four transmitter sites. Here in New Zealand, Radio New Zealand International began its operation on September 26, 1948 with the low power of 7500W, which was increased to 100kW on January 24, 1990.

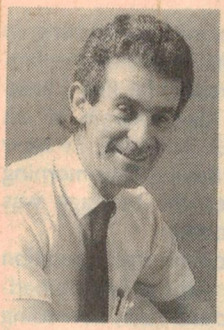
Two of these stations have programmes specifically for the shortwave listener: BBC Waveguide is heard on Sunday at 1030 on 9740 and 11,750kHz; and RNZI, Wellington has Mailbox every second week at 0830 on 9700kHz, in which Tony King answers letters and the writer supplies some shortwave listening information.

Radio Moscow carries gospel programme

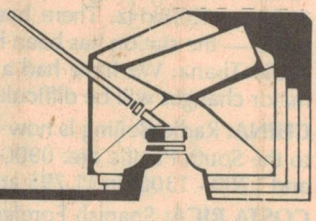
It seems almost unbelievable, the moves that have been made by the former Soviet Union to attract hard currency and to sell time on its multitude of high powered shortwave transmitters.

Perhaps the biggest shock was listening to Adventist World Radio Europe operating on 15,125kHz — opening at 0430 in English, 0500 in German and 0530 in Russian; and at 0600, to hear 'Midnight in Moscow', the Kremlin Bells and the announcement, "This is Radio Moscow's World Service". Things are happening so fast in the former Soviet Union that the unbelievable of a few years ago is now reality. This transmission for Adventists World Radio, sponsored by Voice of Hope, had an announcement in which reception reports were requested to be sent to AWR-Europe, PO Box 383, 1-47100, Forli, Italy. The announcement was repeated each half hour during the programme, after which Radio Moscow World Service continued from 0600 onwards.

In the Far East, the Russian transmitters in Siberia are also being used by Adventists World Radio, as reported in this feature recently, and a verification letter has been received confirming reception on 11,855kHz. The transmitter is located at Novosibirsk, with a power of 100kW, and English broadcasts have been heard 1300 - 1400. The vertification letter was signed by Lina Lega, Secretary at the Forli office in Italy. ❖



Information centre



Conducted by Peter Phillips

Finding the wood among the trees

I like to try and de-mystify electronics whenever I get the chance. This month gives me that opportunity in a small way, as our first two topics illustrate. And for a change we invite discussion about marine electronics, prompted by a reader with a few ideas on boat speedo's.

As technology advances, it seems even the most highly trained technicians prefer to 'change the board' rather than fix it. Certainly it is increasingly more difficult to troubleshoot at component level, either due to the sophistication of the equipment, the compactness of the electronics or a lack of confidence on the part of the repairer.

But quite a few faults in today's hi-tech appliances are probably easily found, if we ignore their complexity and think along the lines our fathers might have. For instance, a compact disc player is just as likely to suffer from a bad connection as a valve amplifier. But once the player starts to misbehave, our reaction is often to look through the 'For Sale' columns for a replacement player.

So in these recessionary times, I wonder whether there's a trend back to fixing the appliance rather than throwing it out. It's been my experience that quite often a fault is mechanical, (stretched belt, worn part) rather than electrical. When it's electrical, very often the basic components (capacitors, diodes) are responsible. The 80-pin (or whatever) IC is often the most reliable component in the circuit.

Our first letter this month illustrates my point, by describing a rather unusual approach to fixing that least repairable device of all: a computer hard disk.

Hard disk repair

This letter is from a (self-confessed) non-technical reader. However, it seems his analytical skills are as good as anyone's when it comes to fixing a hard disk. Well not actually fixing, but getting it to go on a temporary basis. See what you think...

I own an Apple IIGS computer, fitted with a 20MB CMS hard drive. I've had it for some years, and it has performed without fail until several weeks ago, when it refused to respond at all. In fact it caused the whole system to lock up, and had to be unplugged to even let the computer function.

Being totally non-technical, I decided to take it to my Apple dealer, fearing the worst. Before doing this, on the advice of a friend I tried all the usual things like unplugging the drive card, testing the various plugs and sockets and so on. All to no avail, so off to the dealer.

When I arrived, the dealer took my computer and the hard drive into the workshop, where to my amazement and embarrassment, it worked. He poked around for a while, testing the integrity of the various connections (as I had already done), then suggested I take it all home and try again. His only advice was to give the drive a shake if it didn't work when I got it home.

And of course it didn't work! I shook it and jiggled it, but it refused to perform. I then began thinking of any differences between the dealer's workshop and my office. The only answer I could come up with was that the dealer's workshop was air-conditioned.

To test my theory, I decided to unplug the drive and give it a spell in the refrigerator. I suppose I was more surprised than anyone when it worked. As I write, it is performing perfectly, and I now know what to do next time it fails. Any thoughts on why this should be the case? (R.M., Newtown NSW)

I suppose most readers would either not think of this approach, nor admit it if they did. But here we have an example of someone using a technique that we technical types would probably dismiss as primitive and even likely to cause further damage.

After all, placing a sophisticated device such as a hard disk in with the lamb chops and ice cream seems rather ridiculous.

Obviously the fault is temperature sensitive, suggesting a faulty IC or perhaps a 'dicky' soldered joint. The simplest approach to finding this type of fault is to take off the covers (but not the drive's sealed case!), wait until the drive fails, then selectively spray the circuit board with freezer spray until the drive responds. Then replace that component. Simple! (Well, in theory at least...)

Thanks R.M. for telling us this story, as it shows that high-tech doesn't always mean sophisticated troubleshooting techniques.

The next letter pursues this same topic, on a different plane.

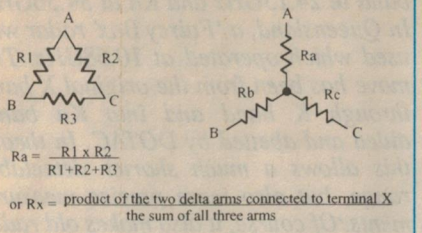
Delta-Wye conversion

I mentioned in December that I had received a lot of letters offering solutions to the cartwheel resistor network presented by a reader (R.V.H., Kallangur Qld). I've now lost count of the number of letters, but it's well over 100. For that reason, I was unable to acknowledge anyone in the column, as the list of names would have filled the allocated space.

But obviously the question struck a chord of interest. Many readers tackled the question using the simple method I presented in December.

However, a lot of readers (especially engineers) chose the delta-wye conversion method. Therefore, because of the interest level in the question, it seems appropriate to describe this method as well. Here's how one reader explained it...

I read your column with great interest and enjoy the What?? question each month. I'm therefore prompted to put



$$Ra = \frac{R1 \times R2}{R1+R2+R3}$$

or $Rx = \frac{\text{product of the two delta arms connected to terminal X}}{\text{the sum of all three arms}}$

Fig.1

finger to keyboard and send you a solution to the resistor network you gave as a secondary question in October.

To solve a resistive network, you need to use the conventional series or parallel resistance equations, but the circuit as drawn doesn't readily allow this. Instead it needs to be converted to one that lets you use these basic equations. This can be achieved by converting the 'delta' networks to 'Y' networks.

The formula to make this conversion is shown in Fig.1 and was obtained from page 449 of 'Introduction to Electric Circuits' by Herbert W. Jackson, published by Prentice Hall.

Fig.2 shows the process, where the original circuit is shown in (a). By converting the top-left, top-right and bottom-centre delta networks, we get Fig.2(b). This simplifies to the circuit shown in (c).

Converting the top-centre delta network in (c) gives the circuit in (d) which simplifies to that shown in (e). Converting the delta network on the left to wye gives (f). From then on it's a simple process to find the total resistance, which is 0.8 ohms.

This method is only one of many possible solutions, but it describes the delta-wye conversion method. I hope you and R.V.H. find this useful. (B.D., Mount Beauty Vic).

Thanks B.D., I'm sure many readers will find your method interesting and a good example of this technique. It is considerably more complex than the method presented in December, but is one many readers used.

So perhaps there's a similar lesson here regarding problem solving. It's often true that using a general but complex mathematical process solves the problem. But sometimes there's a simple way, and one that is more obvious to those who don't know the complex way. Is this an example of the trees getting in the way of the wood?

Teletext decoder

We get a lot of letters suggesting project ideas, and the following letter about an improved Teletext decoder is typical. I'm particularly interested in this topic as I have been thinking along similar lines myself. Here's the letter...

I usually design my own projects, but there is one that I would like to see the magazine do. I'm referring to an improved Teletext decoder.

While Teletext is now available in TV sets costing about $500, they have the problem of being incredibly slow. You can wait several minutes for a particular page to appear, even though its information has probably not changed for several hours.

Wouldn't it make sense to store all the pages as they are being transmitted so that instant access is available? These days memory is cheap, with 1MB of RAM costing around $50. The pages sent by Teletext seem to be simple ANSI graphics and probably don't add up to more than one kilobyte per screen. One megabyte of RAM could store 1000 pages without any data compression.

I remember reading an article in EA a couple of years ago about a single-chip Teletext decoder, but I was not familiar with the I^2C bus used in the design. I therefore didn't make the adaptor.

I realise this suggestion doesn't have a simple solution, but it seems rather like your TV CRO adaptor project. Maybe the magazine could consider developing such a project. (M.M., Wembley Downs WA).

The article you're referring to is probably the Dick Smith Teletext decoder presented in June 1989. You may have noticed my article in the November 1992 issue (page 64) describing a few enhancements to the circuit.

You're quite right about the speed of update, and I've been thinking of ways to solve this. A method I'm currently researching is to interface the decoder to a computer and to store the data in the computer's memory. This would get around gross modifications to the existing unit and allow the data to be displayed by a computer monitor.

More significantly, the data could then be manipulated, stored on disk or treated as conventional computer data. If any reader has further ideas, or has perhaps already done this, I'd be very keen to hear from you.

Coils by computer

On the topic of computers, I printed a request in November from a reader seeking information on computer programs that could be used to design inductors.

A reader (who prefers to remain anonymous) has since sent me details of a program described in *Radio-Electronics*, November 1988, page 67. The program is relatively simple, and is written in BASIC. It suits an IBM type computer, although the program could be run on any computer that supports BASIC.

The article gives the program listing which uses the equation:

$L = 0.2a^2n^2/(3a+9b+10c)$

where:

L = inductance in microhenries
a = average diameter of the coil in inches
b = length of the coil in inches
c = radial depth of the winding in inches
n = total turns of wire

These dimensions are shown in Fig.3.

The program is only for air-cored coils, and suits RF designs rather than audio applications. Note that the dimensions are all imperial, but this shouldn't be a problem to most readers.

Boat speedometer

Back to the topic of suggested projects, here's another that seems simple enough:

The April 1992 edition of EA carried

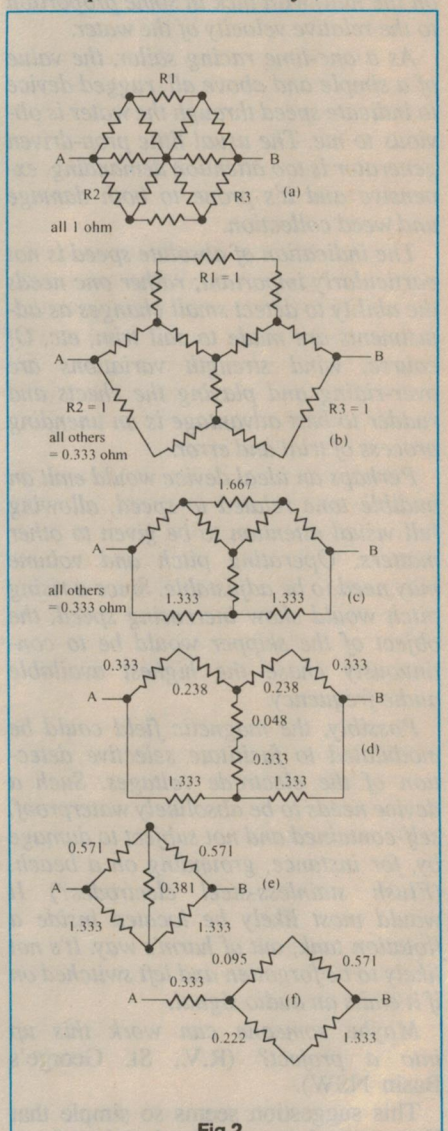


Fig.2

an item on E-M propulsion for a ship. It appears to work by the force so well illustrated by Mr (or was it Dr?) Fleming's 3-finger rule. I forget whether his right or left hand is applicable. No matter. In essence a DC current is passed through the (conducting) sea-water in a strong magnetic field and water is shoved backwards, propelling the ship forward.

The same system will, of course, work in reverse using the rule related to the other of Mr Fleming's hands. If a conductor (in this case water) is moved through a magnetic field, an electric current will be generated in the water — a magneto-hydrodynamic generator.

We appear to have here the basis for a simple speedometer for use in boats. A magnet in the moving craft will create a potential difference between electrodes on the hull, with luck in some proportion to the relative velocity of the water.

As a one-time racing sailor, the value of a simple and above all, rugged device to indicate speed through the water is obvious to me. The usual little prop-driven generator is too attention demanding, expensive and it's prone to both damage and weed collection.

The indication of absolute speed is not particularly important; rather one needs the ability to detect small changes as adjustments are made to sail trim, etc. Of course, wind strength variations are over-riding and playing the sheets and rudder to best advantage is an unending process of trial and error.

Perhaps an ideal device would emit an audible tone related to speed, allowing full visual attention to be given to other matters. Operating pitch and volume may need to be adjustable. Since a rising pitch would show increasing speed, the object of the skipper would be to continuously chase the highest available audio frequency.

Possibly, the magnetic field could be modulated to facilitate selective detection of the electrode voltages. Such a device needs to be absolutely waterproof, self-contained and not subject to damage by, for instance, grounding on a beach. (Flush stainless-steel electrodes?) It would most likely be located inside a flotation tank, out of harm's way. It's not likely to be forgotten and left switched on if it emits an audio signal.

Maybe someone can work this up into a project? (R.V., St. George's Basin NSW).

This suggestion seems so simple that I'm tempted to ask why hasn't it been

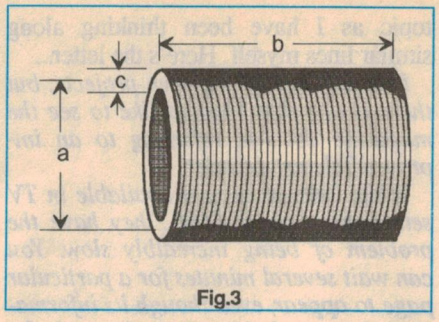


Fig.3

tried before. Then again, perhaps it has and the results were either disappointing or the technology too complex. In any case, it introduces an interest area we don't really address in *EA* — boats.

Although it's been many years since I 'mucked about in boats', I recall the speedo on the craft I once owned was operated with the venturi principle. As I recall, this principle is based on the premise that a pressure differential proportional to the rate of flow is produced across an aperture. The speedo was therefore a form of pressure gauge.

However, the gauge didn't start operating until the speed reached at least 10 knots, suggesting the venturi principle is probably inappropriate to sail boats.

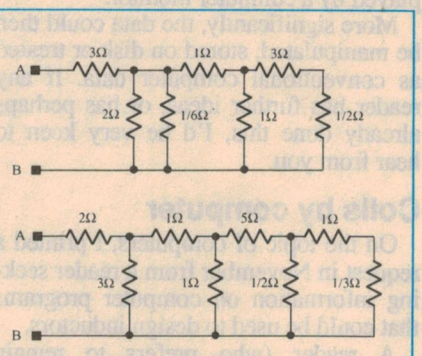
I'd therefore like to hear from a few 'boaties', as I'm sure there are many readers who have experimented with speedos for boats, perhaps on the lines mentioned by R.V.

RD²

What's an RD²? Our next correspondent explains...

Regarding the question in October's EA from B.R. about radar detectors, I have some bad news. It is possible to detect radar detectors. A radar detector is not a passive device like a microwave oven leakage detector, but contains active circuitry.

The X band (which in theory is now no longer used) operates at 10.525GHz, K



all resistors made from 1 ohm resistors, total of 18 in each circuit
R_T = 3.14159292 ohms
Fig.4

band at 24.15GHz and Ka at 34.36GHz. In Queensland, a 'Fairey Box' radar was used which operated at 10.68GHz. The move has been from the original X band through K band and into Ka band, aided and abetted by DOTAC. In theory this allows a much shorter detectable range, but also more precise measurements. Of course, it also makes old radar detectors obsolete.

A radar detector typically has an oscillator Gunn diode and a detector diode built into a waveguide. To detect X, K and Ka bands, various tricks are performed. The oscillator diode is used to demodulate the GHz microwaves.

For the X and K band, the oscillator diode is running at a frequency around 11.5GHz. Typically, this is not shielded at all well, as it is close to the middle of the waveguide. Thus, it tends to act as a transmitting antenna, and the local oscillator frequency is broadcast down the road ahead of the car. This is very useful to the police.

Police use a VG-2 Interceptor from Canada, which is tuned to this local oscillator frequency. However, as any user of a radar detector knows, there is just as much RF interference on SHF as there is on HF, so the radar detector detector (or RD² as we now call it) is renowned for false signals. It can easily be set off by HF and UHF CB's, car alarms and cellular telephones. As you can see, it is not the 'sophisticated detector' law enforcement authorities might suggest. As a result, new detectors have been designed which emit negligible microwaves, and are thus undetectable!

I have done some experiments at a local microwave laboratory on two brands of radar detectors, to check their 'detectability'. One brand emitted around 10uW, another emitted 100uW. Quite a difference. A design engineer at this laboratory has developed an RD² and claims a detect range of 2km.

Regarding ethics and law enforcement, the two are somewhat at odds with each other. Everyone knows that people who drive long distances are the safer drivers. They just happen to be the people who have radar detectors.

It is interesting to note that the Falcon K band Radar Gun in use around Australia will detect cars approaching it as well as those departing it. It has a Doppler tone built in, which should alert the officer that there is more than one target in the beam.

However, you can be booked even if you are observing the speed limit, because a vehicle with a larger radar cross-section going the other way is exceeding the speed limit. The newer ver-

ceeding the speed limit. The newer versions of mobile radar and Ka band radar don't have this problem. (M.G., no address supplied).

From your letter M.G., I gather you are a long distance driver who 'happens to use a radar detector'. However, from what you say, it seems that while the RD^2 units being used suffer from interference problems, they are in fact employed by police.

I'll refrain from any comments about ethics or otherwise, but I suppose it's the old story of the hunter and the hunted trying to outwit each other. For me, I'll just stay out of the hunt!

Pi ohms

The What?? question from October drew quite a few replies, including the comment that the question asked for a value to six decimal places and gave the value to 10 places. Fair enough, but most answers worked on pi (π) being equal to 3.14159292. The circuit in November gives this value.

However, it seems there are simpler circuits, and correspondent Peter White (Beecroft NSW) has calculated two possible circuits that use only 18 resistors, rather than 26.

Incidentally, as Peter points out, a value for pi correct to six decimal places can be found by dividing 355 with 113 (gives 3.14159292). The two circuits sent by Peter are shown in Fig.4 and give a resistance equal to 355/113 ohms.

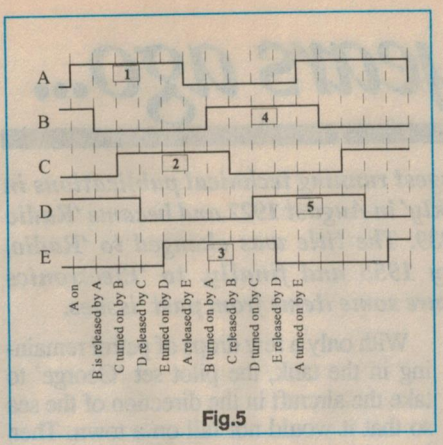


Fig.5

Stop press

I've just received a letter that gives a circuit for pi ohms (3.14159292) that has only 15 resistors. Circuit next month, but perhaps someone can better that!

What??

We haven't had a digital question for some time, and this one might cause a bit of head scratching. It comes from Geoff Harland of Karori, Wellington NZ, who asks:

Design a logic circuit that uses as many AND and OR gates as you like, but only TWO inverters to invert three signals. That is, if the inputs are A, B and C, the outputs will be A bar, B bar and C bar. For any digital input, the outputs will be the inversion of the three inputs.

(You might like to try this using only 2-input gates, as the solution I'll be presenting uses these. P.P.)

Answer to December's What??

The answer is that the relays operate in the order of A, C, E, B and D. The timing diagram shown in Fig.5 helps to explain.

The diagram assumes that the starting point is the operation of relay A. As the diagram shows, this releases relay B (the time delay is included to make the diagram easier to understand). The sequence then continues as shown in the diagram. ❖

NOTES & ERRATA

The circuit for the What?? question presented in November shows R1 equals 100W. Because W converts to the omega symbol when the correct font is selected, obviously I've forgotten to select the correct font: R1 should be 100 *ohms*. ❖

NEW KITS FOR EA PROJECTS

The following new kits have been announced for projects described recently in *Electronics Australia*.

Jaycar Electronics:

LOW COST INDUCTANCE ADAPTOR (December 1992): Carrying the catalog number KA-1746, the Jaycar kit is complete and includes box, switches, terminals, MKT capacitors and adhesive front panel artwork. It is priced at $39.95.

MULTIMEDIA AMPLIFIER (January 1993): The kit for this project is of the 'short form' type and includes PCB, components, toggle switch, pot, fuse and connectors. The speaker is available separately. The kit carries the catalog number KA-1747 and is priced at $24.95.

Dick Smith Electronics:

DISCO STROBE LIGHT (December 1992): The kit for this project is exclusive to DSE and is complete with transformer and all components, case, flash tube and reflector. It carries the catalog number K-3155 and is priced at $109.00.

INDUCTANCE ADAPTOR (December 1992): The kit for this project is complete with pre-punched and silk-screened front panel, punched rear panel and all components. Carrying the catalog number K-7224, it is priced at $49.95.

VK POWERMASTER 25 (January 1993): The basic kit for this project is exclusive to DSE and includes pre-punched case with silk-screened front panel, and all components except the power transformer and optional cooling fan components. Carrying the catalog number K-3400, it is priced at $189.00. The M-2000 transformer is available and priced at $44.95, while the alternative M-2010 transformer is $89.95. The Y-8507 cooling fan is priced at $29.95.

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50 and 25 years ago...

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January 1943

New U-boat engine: It appears that the Germans have had some success with a new type of engine for U-boats. The engine burns oil fuel when surfaced, but for underwater cruising it operates on a controlled mixture of hydrogen and oxygen. Storage tanks are filled under high pressure with these gases before leaving home (it has even been suggested that a means has been evolved for manufacturing the gases on board).

Elimination of the electro motors and the vast banks of accumulators would make for much greater efficiency, since these items constitute as much as one-sixth of the total weight of the craft.

A triumph for 'George': 'George', the automatic pilot, brought off a 100 to 1 chance by landing an empty aeroplane successfully after the crew had bailed out.

With only a few drops of petrol remaining in the tank, the pilot set 'George' to take the aircraft in the direction of the sea so that it would not fall on a town. Then he and the crew bailed out over land.

The aerodrome staff heard the plane approaching, but despite their rockets and flares, the craft paid no attention and passed on towards the coast. Later, someone phoned up in great excitement to say that the aircraft had made an almost perfect landing on the beach — empty!

January 1968

First IC car voltage regulator: General Motors is reported to be the first in the field with an integrated circuit voltage regulator. The device is now being fitted to the 1968 model Pontiacs.

The standard electromechanical voltage regulator is prone to relay-contact erosion and wear, which introduces unwanted resistances that change circuit regulation.

The General Motors IC is a hybrid; transistors, diodes, resistors, a capacitor and thermistor are mounted on a ceramic substrate. If the generator output rises above its preset limits — detected by sensing the voltage at the battery terminals — the zener diode breaks down and switches off the transistors which control the generator field current. As the generator output drops, the zener turns off and full current is again applied to the generator field. The thermistor provides temperature compensation in a voltage-divider configuration.

Computer graphics: The Lockheed Company has been awarded a US$68,000 contract by NASA to analyse application of 'computer graphics' to America's space effort. Computer graphics will allow space engineers and scientists to work out their complex problems and design in visual form, using a photo-sensing light pen to 'draw' on the face of a cathode-ray tube display linked directly to a computer.

Areas being studied are the design of electronic circuitry and hypersonic re-entry bodies, structural dynamics and trajectory analysis. Because engineers get feedback quickly, they can do a better job of reacting to problems as they arise. ❖

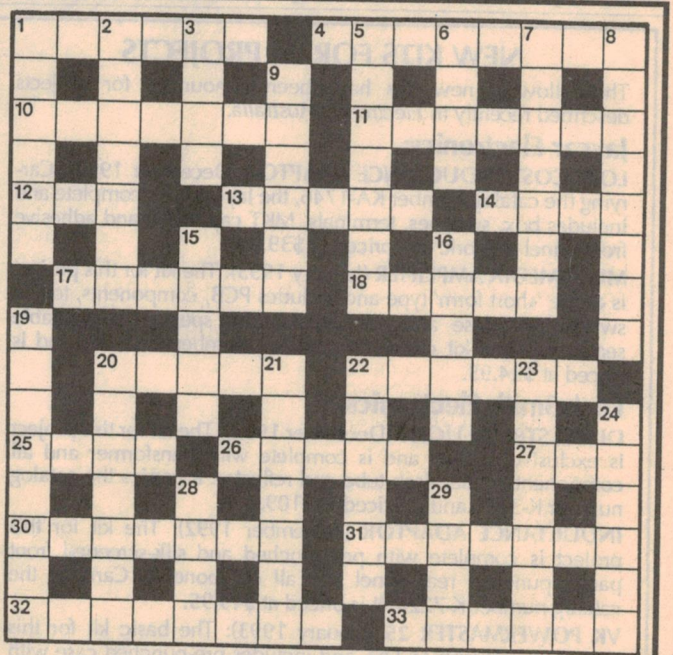
EA CROSSWORD

ACROSS

1. Brand of electric home appliance. (6)
4. Place excess demand on a device. (8)
10. Exceed safe rate of motor speed. (7)
11. Attends to audio stimulus. (7)
12. Frequency band used for TV. (1,1,1)
13. Versatile musical instrument, the electronic ——. (5)
14. Alternative setting to manual (abbr). (4)
17. Generator. (6)
18. Complete a circuit by switching. (5)
20. Metric prefix for factor of 10^2. (5)
22. TV studio technician, the —— mixer. (6)
25. Photographic fixing agent. (4)
26. Hobbyist's workplace. (5)
27. Shocking animal, the electric ——. (3)
30. Type of image not seen on a screen. (7)
31. Add sound track. (7)
32. Goes beyond set time (possibly in TV cricket?) (4,4)
33. Founder of the Jodrell Bank radio telescope. (6)

DOWN

1. Arrange a communications link. (4,2)
2. Direct an aircraft above a specific area. (7)
3. Site for microamplifiers. (4)
5. Said of a certain cell. (7)
6. Corrosion that can be reduced electrolytically. (4)
7. Operate excessively. (7)
8. Become aware of fact, phenomena, etc. (8)
9. Carry beyond a limit. (6)
15. Circuit held in stable position.(5)
16. User-friendly device. (5)
19. Something easily done (instantly with a button?) (8)
20. Subatomic particle. (7)
21. Exist as superior layer. (7)
22. Physical quantity with directional quality (6)
23. Said of things behind time. (7)
24. Covering the world. (6)
28. Early satellite-launching rocket with name of goddess. (4)
29. An exhibition of equipment in use (abbr). (4)



SOLUTION FOR DECEMBER 1992

B	R	O	A	D	B	A	N	D		O	P	T	U	S
Y		U		Y	N		I		V	R		U		
T	I	T	A	N	I	C		F	E	E	D	E	R	S
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D	R	Y	E	R		D	I	A	G	N	O	S	I	S

EA with ETI marketplace

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THE SERVICEMAN

Continued from page 59

in a cluster of eight 1N5404 diodes. A number of patterns of diode placement would function, as it was a symmetrical circuit.

Various workers used different layouts on successive runs and it was important during testing to ensure correct orientation. Often, the circuit would function correctly with a reversed diode, but eventually the germanium diode and an associated BC549 would cook.

When units are returned with an auto-start problem, the first check is to confirm the orientation of the diodes and then test them for damage. One inverter was returned showing all the symptoms, but the diodes checked out perfectly. In this model we had linked the chassis and power point earth to battery negative. With this unit, we reasoned that there could have been a problem with the customer's system, since the damaged components were located between neutral and ground. So our agent sold the customer a later model, with a MEN compatible arrangement and eventually sold the first unit as an ex-demo model. But a few weeks later it was back with the same problem.

I completed the usual visual examination of the diodes, then turned the board over to check their electrical characteristics. We use a very effective lacquer on these boards and it is much easier to probe the solder pads than to get a reliable contact through this coating.

To shorten what is developing into a long story, it turned out that one of the diodes had been marked wrong way round — the cathode band was on the anode end!

How this could occur to an isolated component is a mystery. We were buying 1N5404's in bulk, thousands at a time, so I'm left wondering if there are any more of these aberrations out there, waiting to cause us further trouble.

Watch out!

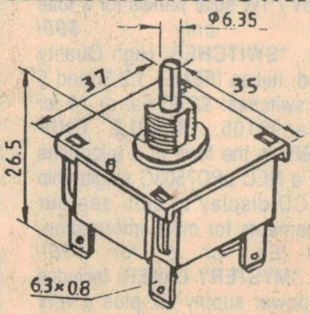
Thanks, G.C., I certainly will. And so will a lot of others, now that your findings are being made public. Considering that these diodes are made by the millions in totally automatic machines, it defies imagination to work out how any of them could complete the process yet be wrongly marked. All I can suggest is that it might have been removed for inspection along the way, then replaced on the line wrong way round. If the inspection was for 'Quality Control', then it doesn't say much for that company's QC, does it?

We'll be back next month with more contributors stories. See you then? ❖

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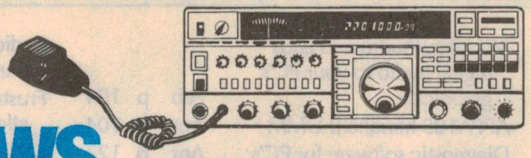
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Amateur Radio News



Shuttle promotes amateur radio

The *ARRL Newsletter* of 24th September 1992 reports on the amateur activities of the Space Shuttle Mission which landed on 20th September.

Quoted is one of the beacon messages from the shuttle's packet robot:

1400 UTC 18 September. We had a nice demonstration today of amateur radio's ability: The White Sands, New Mexico, ground station for the data relay satellites NASA uses for our shuttle air-ground comms went off the air unexpectedly for about 15 minutes. As it happened, this was just prior to a planned school contact via Andy VK4KIV. Andy relayed to Houston's mission control centre for us and bridged the gap in communication via ham radio! We were able to learn exactly what the problem was, and told MCC what our plans were, averting any possible confusion. Thanks, Andy.

More than 600 amateurs connected to the Shuttle's robot packet station in the first 24 hours of the mission. Some 456 amateur stations were logged as 'worked' on packet, and many excellent voice contacts were achieved.

QSL or SWL cards should be sent (with an SASE) to Jay Apt, N5QWL, 806 Shorewood Drive, Seabrook, TX77586, USA. The next scheduled flight will be on 18th February 1993.

IARU Region 2 HF bandplanning

The September 24 *ARRL Newsletter* also reports on the meeting of the General Assembly of Region 2 of the IARU, held in Netherlands Antilles from 31st August to 4th September. Amateurs from 34 Western Hemisphere nations, including 10 proxies, attended.

One of the main topics discussed was HF bandplanning, with emphasis on digital segments to reflect current usage and to align the Region 2 plans with Regions 1 and 3. Apart from the 7MHz band, where USA allocation does not coincide with allocations in other parts of the Region, agreement was fairly well achieved.

The resultant agreement designates segments for 'Digital Modes', with a sub-segment designated 'Packet Priority'. Recommended HF band segments for CW and for radiotelephone (including SSTV and FAX) were unchanged; CW is still acceptable in all segments.

The agreed HF digital segments are as follows:

80 metres: 3580 - 3635kHz, packet priority 3620 - 3635kHz.

40 metres: 7035 - 7050kHz, packet priority 7040 - 7050kHz (international), 7100 - 7120kHz (within Region 2).

30 metres: 10.130 - 10.150MHz, packet priority 10.140 - 0.150MHz.

20 metres: 14.070 - 4.112MHz (with 1kHz guard band at 14.100 for the beacon network), packet priority 14.095 - 4.0995MHz, packet shared with SSB at 14.1005 - 4.112MHz.

17 metres: 18.100 - 18.110MHz, packet priority 18.105 - 18.110MHz.

15 metres: 21.070 - 21.125MHz, packet priority 21.090 - 21.125MHz.

12 metres: 24.920 - 24.930MHz, packet priority 24.925 - 24.930MHz.

10 metres: 28.070 - 28.189MHz, packet priority 28.120 - 28.189MHz. ❖

THE 1993 GOSFORD FIELD DAY

FOR RADIO AMATEURS AND ENTHUSIASTS, COMPUTER AND ELECTRONIC HOBBIESTS SUNDAY 28TH FEBRUARY 1993 AT THE WYONG RACECOURSE - GATES OPEN 8AM

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- See all major Amateur Radio equipment suppliers together under one roof with many dealers displaying the latest products and offering once in a year bargain prices.
- Interesting technical lectures
- Packet Radio - Computerised Communications Displays.
- Radio fox hunts.
- Amateur television transmission displays.
- Entrance fee only $6.00. Pensioner concession $3.00. Senior card $5.00. Children under 12 free.
- Free off street parking.
- Free sightseeing tour of the Central Coast.
- Free entry tickets to the Australian Reptile Park.
- Bring your picnic lunch or buy hot and cold food and drink from the stalls in the grounds.

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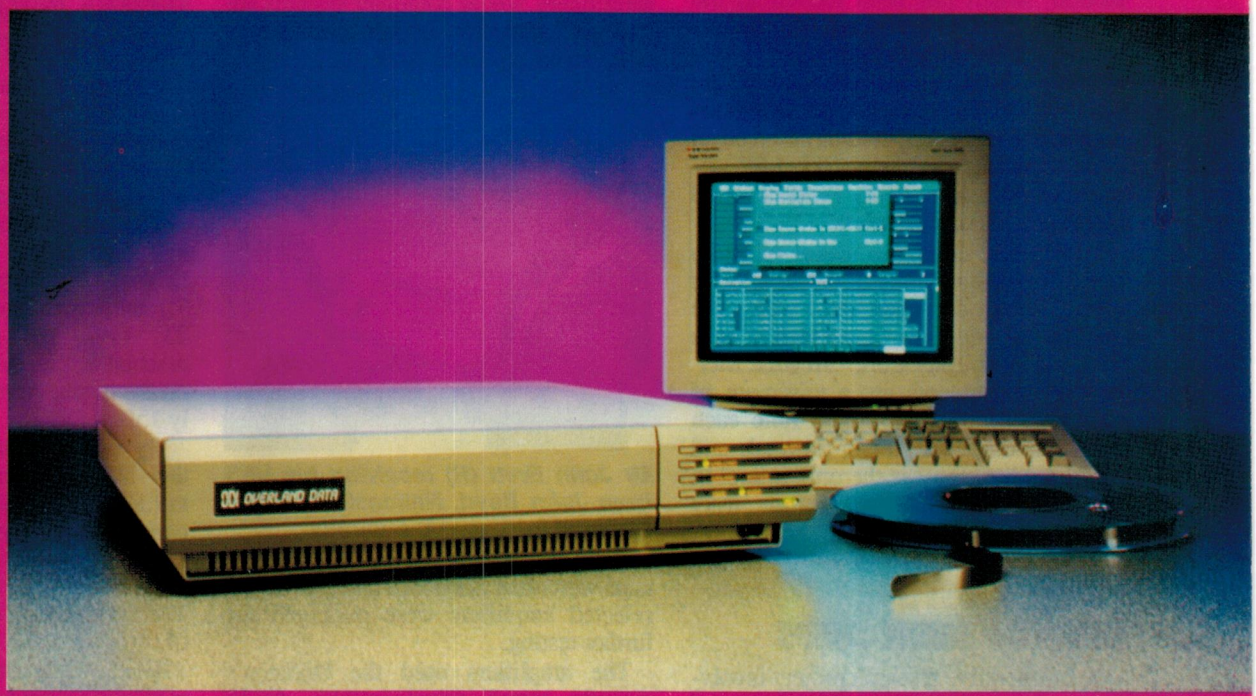
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S·U·P·P·L·E·M·E·N·T

UNDERSTANDING QUALCOMM'S CDMA DIGITAL CELLULAR

REVIEW OF UPGRADED LEAP, LMS PACKAGES FOR SPEAKER DESIGN

CSIRO, DSTO DEVELOP WIDEBAND MMIC AMPLIFIER CHIPS





OVERLAND DATA'S COMPACT 9-TRACK TAPE DRIVES FOR PC'S AND WORKSTATIONS

DATAPRODUCTS' NEW COLOUR PRINTER USES SOLID INK TECHNOLOGY

NEWS HIGHLIGHTS

MELBOURNE SAE GETS AUTO MIXER

Melbourne's School of Audio Engineering has acquired a 'state of the art' Sony MXP-3000 automated mixing console, and the School's staff are confident this will provide its students with hands-on knowledge of the latest advancements in professional audio technology.

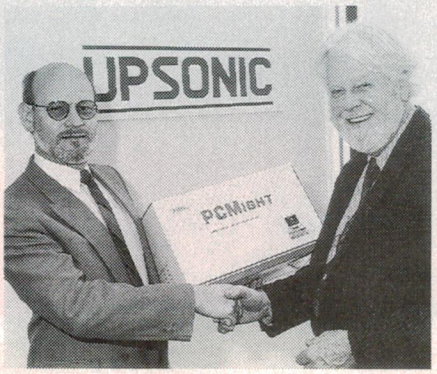
The MXP-3000 is replacing a Tascam M-600, which has been moved to the Adelaide SAE. Other recent acquisitions by the Melbourne School include two new eight-track studios based around the Tascam M2516 desk and the TSR-8 recorder, and two MIDI studios based on an Atari computer running CUBASE sequencing software, EMU Proteus sound modules and Akai samplers.

"The most important aspect of audio education is the quality of the equipment one learns on, coupled with the quality of education presented", says SAE manager Tony Corr. "At SAE Melbourne, all students get a minimum of four hours individual studio time each week, in our eight track, 24-track and MIDI studios. SAE is the only school in Melbourne offering tuition on truly professional equipment."

For further information, contact SAE on (03) 534 4403.

UPSONIC UPS PROMO WINNERS

Seven lucky *Electronics Australia with ETI* subscribers have won Upsonic PC Might 55 uninterruptible power supply (UPS) units, in the subscription promotion which ran in the issues for July-September 1992. Here are the lucky subscribers, whose computer systems are now well protected against blackouts or other mains power failures:



Mr John Brett (R) receiving his UPS from John Boyd, National Marketing Manager for Upsonic Australia.

Russel Brown, of Canberra, ACT;
Richard Keegan, of Toongabbie, NSW;
John Brett, of Mt. Martha, Vic;
Steve Matthews, of Caringbah, NSW;
Rupert Peterson, of Tura Beach, NSW;
Helmut Schiretz, of Narrabundah, ACT; and
Ross Wood, of Springwood in NSW.

Our thanks to Upsonic Australia for its sponsorship of this promotion, and congratulations to the above winners.

OZONE HOLE LARGEST EVER

Preliminary results from NASA's Total Ozone Mapping Spectrometer (TOMS) onboard the Nimbus-7 satellite show that the area of the 1992 Antarctic ozone hole is the largest on record.

The previous surface area covered by low total ozone values, less than 220 Dobson Units, typically has reached near 7.7 million square miles. On September 23, 1992, the surface area covered reached 8.9 million square miles, an increase in size from 1991 of approximately 15%.

By comparison, the surface area of the North America continent is 9.4 million square miles. The 48 American contiguous states have a surface

CSIRO & DSTO DEVELOP MMIC AMPS

A co-operative research project involving the CSIRO's Division of Radiophysics and the Defence Science and Technology Organisation (DSTO) has resulted in the successful fabrication of three-and four-stage wideband monolithic microwave integrated circuit (MMIC) distributed amplifiers, for DSTO's Electronics Warfare Division.

The EW Division of DSTO managed by Mr David Mason, took advantage of a special service offered by CSIRO's Division of Radiophysics to Australian companies and R&D institutions. As part of this collaborative program, DSTO engineer Geoffrey Knight was instructed in the design techniques required to produce MMIC's, working at the CSIRO's semiconductor laboratories in Epping, NSW with the Division's John Archer, Bob Batchelor and Oya Sevimli.

The designs produced using CAD systems were then fabricated and tested, and selected amplifiers were packaged for further testing.

The amplifiers used the Division's recently tested pseudomorphic GaAs HEMT (high electron mobility transistor) devices, with gate lengths of around 0.25um long and 125um wide, and shown to be capable of operating to 100GHz.

The distributed amplifier configuration was chosen, as this has inherently low sensitivity to processing variations. A distributed amplifier uses a number of active devices, with transmission lines at both input and output to allow effective addition of their transconductances while maintaining a wide bandwidth.

Two designs were tested, one using three HEMT devices for wide bandwidth and high yield, and the other four devices for high gain and better noise figure. Both amplifiers were realised in MMICs measuring only 2.1 x 2.85mm.

The results were very encouraging, with the performance of the tested devices agreeing well with simulations. The three-HEMT devices achieved a gain of around 7dB with a bandwidth of 25GHz, while the four-HEMT devices achieved higher gain with a bandwidth of about 18GHz. The devices also showed high performance consistency, showing an advantage of MMIC technology over hybrid technology.

The success to date has resulted in a second contract being negotiated with DSTO, for the development of millimetre-wave amplifiers.

CSIRO's Division of Radiophysics is now also developing a new series of millimetre-wave HEMTs and a range of dual-gate HEMTs for variable-gain and mixer applications.

The Division is keen to enter into co-operative programs similar to that undertaken with DSTO, with companies wishing to develop prototype MMICs. Further information is available from Dr John Archer or Mr Bob Batchelor on (02) 868 0222.

VINTAGE RADIO CALENDAR FOR 1993

Resurrection Radio has published the first of what it hopes will be an ongoing series of annual Vintage Radio Calendars,



featuring high-quality colour pictures of classic valve radio models on each month's vertical spread. The 1993 Calendar features many of Australia's most famous mantel model sets of the 1930's and 1940's, represented by beautifully restored examples.

Each month's spread provides text explaining the background of the set model shown, and giving brief technical details. There are also smaller black-and-white supporting illustrations, to provide further interest.

The Calendar is 'international' in orientation, with references to public holiday dates in many countries. This would make it ideal as a gift for vintage radio enthusiasts anywhere in the world.

Priced at $18.95, the Calendar comes in a mailing envelope made from recycled paper and is available from Resurrection Radio, 51 Chapel Street, Windsor 3181 (PO Box 1116); phone (03) 529 5639.

area of approximately three million square miles, while Antarctica has 5.1 million square miles.

Since the mid-1980's, the region covered by low total ozone values begins to grow in early August. The region covered usually reaches its greatest extent in early-October. This is the fifth year since 1986 that large seasonal ozone reductions over the Antarctic have been observed.

LIMIT TO MAGNETIC INFORMATION STORAGE

Scientists from the University of California at Santa Barbara and the IBM Corporation have observed a quantum effect that limits the amount of information that can be stored on magnetic media, such as audio tape and computer disks.

The effect, called macroscopic quantum tunnelling, becomes significant at sizes about 10 times smaller than those used by current magnetic recording technology and represents an ultimate barrier to the ongoing process of packing increasing amounts of information onto magnetic media.

Macroscopic quantum tunnelling and its occurrence in magnetic materials has been predicted for 20 years.

The effect causes groups of magnetic atoms to act like single magnetic units and was seen in a naturally occurring iron storage protein called ferritin found in horse spleen, according to a report by physics professor David D. Awschalom and Dr Joseph F. Smyth of UCSB and David P. DiVincenzo from IBM's Thomas J. Watson Research Center that appeared in a recent issue of the journal *Science*.

The researchers used ultra-sensitive magnetic measurement techniques that allowed them to record the behaviour of magnets one hundredth the size of those that have been previously studied. They determined that, when the 4500 iron atoms that make up a ferritin core were cooled to very low temperatures, their magnetic fields began to fluctuate together, rather than freezing in place. Such behaviour is not consistent with classical theories of magnetic behaviour, but it is predicted by quantum mechanics, the theory that describes events at the atomic level.

This form of quantum tunnelling appears at a scale of about 7nm (nanometres). Because it prevents smaller groups of atoms from being held in any given orientation, the effect establishes a de facto upper limit for the amount of information that can be packed into a given area on a magnetic surface.

HIGHEST OUTPUT LASER DIODES

Toshiba Corporation in Japan has introduced two new types of red-light visible laser diodes. One achieves an output power of 5mW, the world's highest output for a model with a wavelength of 650 nanometres (nm), in an ambient temperature of up to 50°C. This is approximately 66% higher than the output of Toshiba's previous model. The other achieves the world's shortest wavelength, 635nm, and offers 3mW output power.

The main application of the new lasers



SIEMENS OTDR FOR ANTARCTIC

Siemens has supplied one of its K2300 optical time-domain reflectometers for use in the Antarctic by the Australian Antarctic Division, to test the fibre optic local area networks (LANs) being installed at each of its four stations.

The hostile environment of the Antarctic requires equipment to be extremely rugged. The Antarctic is isolated for six months of the year, therefore no supplier maintenance is available.

To meet the severe environmental requirements, Siemens performed additional reliability testing on the K2300 in conjunction with its normal quality checks. This testing included using a truck to transport it over rough terrain for several days. This testing was performed to ensure the unit would remain functional when being moved from one LAN site to another.

Delivery deadline for the equipment was also of utmost importance, as ships to the site leave Tasmania only once every six months. A Siemens representative hand delivered it to the Tasmanian office to ensure its safe arrival.

is in bar code readers. Demand for red-light emitting laser diodes offering greater accuracy in reading bar codes is increasing. One way to improve accuracy is to increase output power at the same wavelength and operating temperature. Also, a shorter wavelength, as close as possible to 633nm, improves accuracy, as standard bar codes are designed to be read by helium neon (He-Ne) gas lasers with a 633nm wavelength, the type of laser now widely used in the fixed bar code readers found in stores and other business applications.

This progress in wavelength shortening and high output power was achieved by using a more advanced structure called the multi-quantum well (MQW) diode structure, instead of the widely used selective-barrier ridge (SBR) structure. Its adoption reduced energy loss in the conversion of electrons to the laser beam, so lowering operating temperature and improving reliability.

SPACE AGREEMENT SIGNED

NASA and the Russian Space Agency (RSA) have signed two cooperative agreements in Moscow, in the areas of human space flight and Mars exploration. The agreements were signed by Administrator Goldin and RSA Director Yuri Koptev during the first annual US/Russian Space Policy Consultations.

"Signing these two agreements is the next crucial step in expanding cooperative space activities with our Russian partners. We are very anxious to begin working on these important programs," said NASA Administrator Daniel S. Goldin.

The Human Space Flight Agreement outlines the flight details of a Russian cosmonaut on the US Space Shuttle, the flight of a US astronaut on the Russian Mir Space Station and a joint mission including the rendezvous and docking of the Space Shuttle with the Mir Space Station.

The Mars '94 agreement is for the flight of two US/NASA scientific instruments on the Russian Mars '94 lander.

SMALLEST CELLULAR PHONE IN AUSTRALIA

What is claimed as the world's lightest and smallest hand held cellular telephone has been launched on the Australian market, by the Wollongong-based MH Group's joint venture, Audiovox Pacific.

The Audiovox MVX-700 'Minivox Lite' hand held telephone weighs in at



178 grams, which is claimed to be some 30% lighter than its nearest rival. And at 1.6cm thick and 15cm long, it is also very compact.

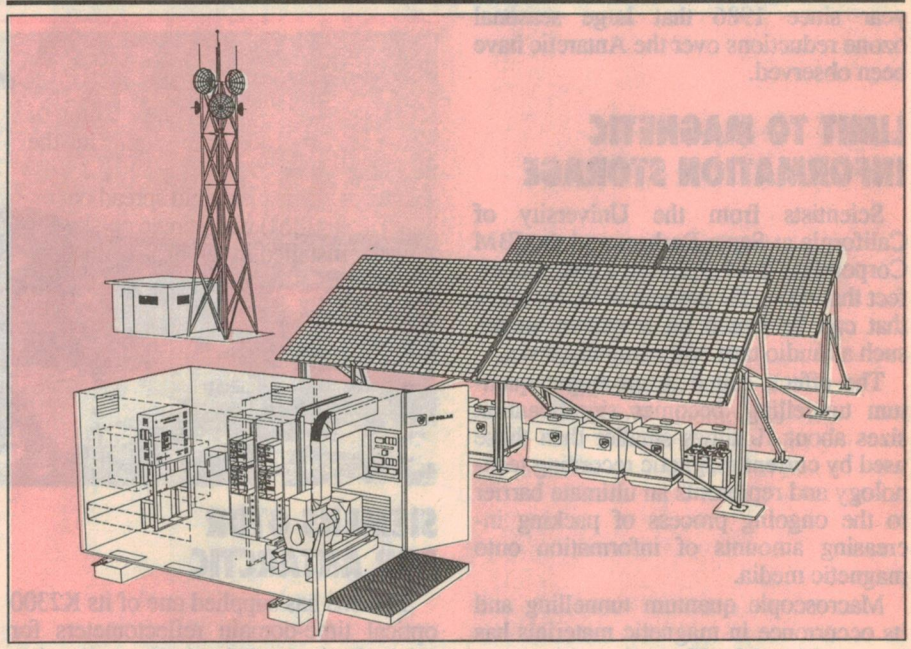
The key to its miniaturisation is its micro-elements and nickel metal hydride battery, which is around half the size of the nickel cadmium batteries used in previous Audiovox hand held telephones. Running on its high capacity standard battery, the Lite offers over 60 minutes of talk time and 12 hours of stand-by. An extended life battery is optional and boosts talk time to 100 minutes and stand-by to 20 hours.

Built in standard features include 101 alphanumeric memory locations, one touch dialling, speed dialling, programmable emergency calling, last three number redial, battery life and signal strength indicators and a 'stay alive' feature that allows the user to change batteries without losing a call. Recommended retail price is $2495.

RAIL WARNING SYSTEM

The number of level crossing accidents in Australia could fall significantly, following the release of a new track warning system developed by a South Australian company. Adelaide based rail signal control specialist, Teknis Electronics was to install and trial the system before Christmas at a number of locations north of Adelaide.

The warning system has already attracted the attention of Japanese rail authorities, boosting Teknis Electronics' hopes of strong export sales in 1993. Local rail authorities, Australian National



POWER SYSTEMS FOR PNG TELECOMMS

BP Solar Australia has recently won a major Post & Telecommunication contract supplying six DC Hybrid Integrated Power Systems (DCHIPS) for their telecommunication towers in PNG.

This is the second part of the contract BP Solar Australia have been awarded; the first DCHIP System was installed on top of Mt Mission, PNG as a pilot project to test the feasibility of having this type of system in such a remote area.

BPSA beat some prestigious competition. DCHIPS will be a key element in this business. Each system had to be air lifted by helicopter to the mountain.

and Queensland Rail are also showing keen interest.

Most Australian level crossing warning systems rely on an approaching train to activate track-based circuits linked to flashing lights, boom gates or barriers. These systems require constant maintenance and safety checks, cannot determine whether a crossing is obstructed by a vehicle accident and may not be activated if a train fails to 'make' the circuit.

The Teknis Electronics device uses monitoring sensors and radar links independent of any track circuit to activate warning systems, and can alert train drivers to possible dangers ahead at a road/rail intersection.

Teknis says the system is safer, half the cost of conventional level crossing technology, and by computation, reduces the time road traffic has to wait at a crossing.

SIEMENS TO MAKE MDF IN MELBOURNE

Siemens has chosen its Australian factory, in the Melbourne suburb of Bayswater, to manufacture the Series 2000 main distribution frame (MDF) equipment. The local company expects sales of the equipment to be substantial over the next three to five years. A large slice of this will be export dollars earned for Australia.

MDF equipment is the wire interconnection between home or office equipment and the electronic telephone exchange which actually supplies the service.

Peter Pech, Siemens Manager for MDF Projects, said the company could see great potential in the export market for this product. "Good planning and marketing, with a clear view into the future, and total management support have made it possible for us to look beyond the local market for the Series 2000 MDF equipment. We have been supplying this equipment to Telecom in Australia and New Zealand for a number of years already. In addition we have secured long term orders for the supply of MDF equipment to Papua New Guinea and we are also in the running in other areas, through close cooperation with Telecom Australia."

LIVE RACES ON WIDESCREEN TV

Sydney racegoers are the first to experience live widescreen TV coverage of an Australian sporting event. For the four meetings of the Australian Jockey Club's Spring Carnival, Hoyts Television supplemented their normal TV coverage of the Randwick races with a widescreen view supplied by Philips BTS.

The Panoramic widescreen (16:9 ratio) images were generated from a BTS LDK91 smear-free frame transfer CCD camera, with a 14X anamorphic lens. It was manned by Peter Salter of Hoyts, from a prime position in the members' stand.

Punters watched the field spread out on Philips 88cm (36") widescreen colour TV receivers, installed in the busiest areas of the public and members' stands. Between races, patrons were fascinated by the widescreen replays, plus unusual views of the Spring Carnival attractions like VIP visitor Elle McPherson, judging the fashion stakes.

Hoyts Television's racing director, Alan Gurr described the AJC's Spring Carnival as ideal for demonstrations of the widescreen format. "Widescreen will do for television what 'CinemaScope did for the movies in the 50's," he said. ❖

ROYSTON WINS ELENEX AWARD

At the recent Elenex/Automate '92 Exhibition, Royston Electronics was awarded 'The Best New Australian Electronic Product on Show'. The Award was presented to the Managing Director, Mr Alan Royston, by the then Shadow Minister for Trade & Manufacturing, Mr Roger Pescott.

The Award was presented to Royston Electronics in recognition of its creation of a state-of-the-art low cost thermal profiling preheating system, Model PH9000. It provides repair technicians with the same level of thermal process control in repairing complex PCB assemblies, as manufacturers, employing sophisticated and expensive wave soldering, hot gas/air convection, or infra-red reflow soldering systems.



NEWS BRIEFS

- ***Lako Vision*** has opened a new Sydney office, headed by Mr Ninus Daniels, which will service Sydney and Canberra. Its address is Level 6, 90 Mount Street, North Sydney 2060; phone (02) 959 5393, fax 959 5760.
- CHASE has appointed ***Elmeasco Instruments*** as Australian agents for its range of EMC & Communication test and measuring equipment.
- The 9th International Computer Expo and Conference, ***Computer '93***, will be held at the Hong Kong Convention & Exhibition Centre on May 12-15, 1993. Its theme is 'A Vision for the Future'. For more information, phone Business & Industrial Trade Fairs in Hong Kong on (852) 865 2633, fax 866 1770.
- ***AWA*** has announced several new key appointments. Peter Smith and Laurie Mackecknie have been appointed Group General Managers of AWA Defence Industries and AWA Communications, respectively. Neville Parr has moved to AWA's Head Office at Ryde as General Manager — Manufacturing Programs.
- Mr Kiyo Sakamoto has replaced Mr Hiro Shimomiya as Product Marketing Planning Manager (Audio) at ***Kenwood Australia***. After 11 years in Australia, Mr Shimomiya has taken up a senior position at the Head Office in Tokyo. Mr Sakamoto was previously the Kenwood Sales Manager for the Middle East, Asia and Africa.
- ***Intel Australia*** has moved to a new address at Unit 1A, Aquatic Drive, Frenchs Forest 2086; phone (02) 975 3300, fax 975 3375. Its postal address is PO Box 1486, Dee Why 2099.
- Sydney-based video and electronic presentation specialists, ***Animotion Design***, has been appointed an Apple Authorised Reseller. For the past 15 months, the company has been trading as an Associate Reseller, supplying Macintosh computer solutions for video production.
- BMI (Basic Measuring Instruments) has appointed ***Elmeasco*** as exclusive distributor for its range of Electric Power Analysers in Australia. ❖

NEW PRODUCTS

COMMUNICATIONS

Cordless phone with TAM

Panasonic Australia has released its latest cordless telephone with a built in telephone answering machine, the KX-T4300BA. The unit offers remote control of an answering machine from the cordless handset, as well as many other new features.

While the base station contains the actual answering machine, all functions are operable from the cordless handset including screening of incoming calls; playing back all messages or just new ones; fast forwarding and rewinding; and interrupting incoming messages if you wish to talk to the caller.

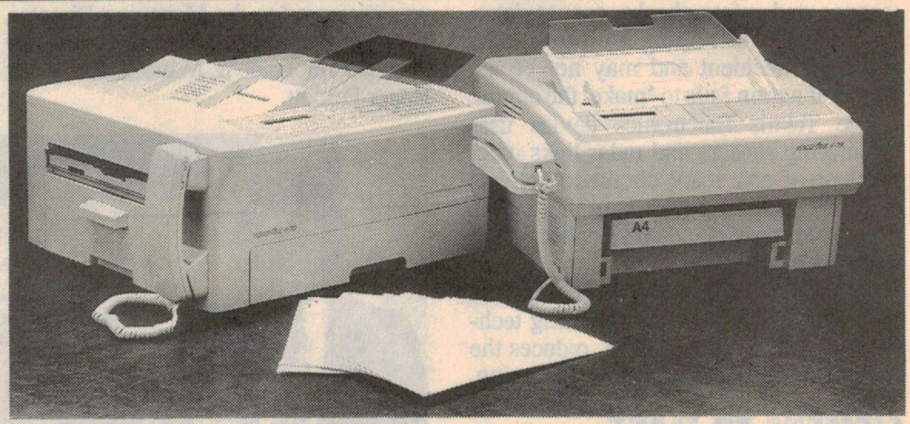
The two way intercom allows you to put your caller on hold and talk via the intercom to someone at the base unit.



Like Panasonic's other cordless phones, the KX-T4300BA incorporates 'Dynamic Sound Focus' technology to ensure clear sound. To prevent interference from neighbours' cordless phones, this model also offers a channel selector — activated by simply pressing a button, while you are talking, to find the clearest of five channels.

Another design improvement is the retractable rubber antenna, which is short and flexible so you don't bump into anything while walking around with the phone. RRP for the unit is $499.

For further information circle 242 on the reader service coupon or contact Panasonic Australia, 1 Garigal Road, Belrose 2085; phone (02) 986 7400.



Plain paper fax

With the new Voca-Fax F-70 and F-75, incoming faxes are automatically printed on exactly the same 80gsm bond paper as used by the office word processor and photocopier.

Both units have built in memory which means that should the Voca-Fax run out of paper, the machine will automatically store incoming documents until the paper supply is replenished.

This memory also enables the storing of documents for delayed commands such as polling, broadcasting and error correction. It also offers Securemail, in which confidential transmissions are stored in the memory bank until the intended recipient presents the correct pass code.

The top of the range F-75 gives a laser print finish to incoming documents, and can be linked to a personal computer, network or mainframe. This enables computer based fax transmission, reception and storage.

For further information circle 241 on the reader service coupon or contact Voca Communications, 11-29 Eastern Road, South Melbourne 3205; phone (03) 697 7000.

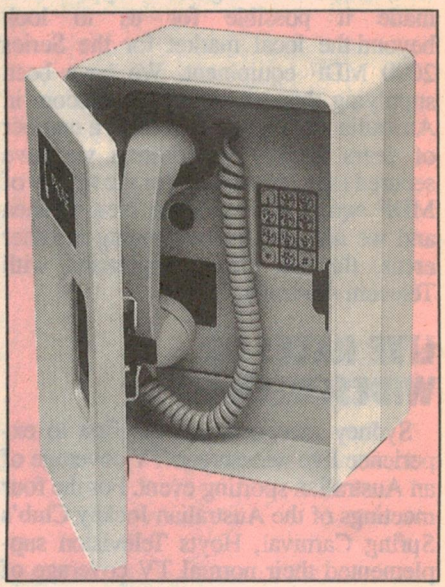
Tough phones

Where a standard telephone will just not do the job, new industrial phones built to take corrosion and abuse, are now available. The anti-corrosive phones, models 246/256 are made by GAI-Tronics Corporation, and are ideally suited to public areas, airports, parking garages, plant entrances and marine terminals.

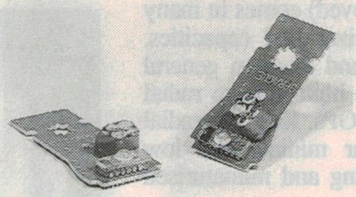
These rugged phones are sealed from dust, dirt and moisture, which gives them a long life even in harsh environments. They can be installed on any single loop line, and provide both tone and pulse signalling (field selectable) along with memory dialling (stores nine 16-digit numbers), as well as last number redial.

The outdoor model enclosure is made of a high impact, anti-corrosive glass reinforced polyester, making it highly resistant to chemicals and solvents. Both indoor and outdoor phones come in modular designs, and provide a hinged front panel for easy maintenance and installation. All units can be optionally supplied with noise cancelling microphones for environments with high levels of background noise.

For further information circle 243 on the reader service coupon or contact Bailey Controls, 26 Auburn Road, Regents Park 2143; phone (02) 645 3322.



Low cost optical motion detector



Oatley Electronics is currently offering at very low cost a PCB assembly featuring the Sprague ULN-2232A optical motion detector chip. This device is virtually a complete optical motion detection system, capable of operating in either active or passive modes and sensing in a conical zone measuring three feet in diameter at eight feet from the device.

The device integrates a photodiode, complementary linear amplifiers, I^2L logic and counting circuitry, a D-A converter, clock oscillators and power transistors on a single chip, mounted in an optically transparent package with a moulded lens. It is functionally very flexible, and can be used in a wide range of sensing, monitoring and control applications.

Oatley is supplying the assembly complete with device data and applications information, for only $6 each or five for $25 — much lower than alternative sources.

Further information is available from Oatley Electronics, PO Box 89, Oatley 2223; phone (02) 579 4985.

XLR/6.5mm 'combo' connector

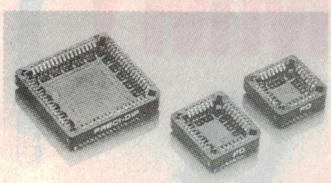
The majority of today's audio equipment is provided with dual input connectors — 3-pin XLR type connectors for balanced, low impedance signals and 6.5mm phone jack sockets for unbalanced, high impedance signals. In most cases, only one of the inputs is used at any given time.

The Neutrik NCJ6FK 'Combo' connector consists of a 3-pin XLR female PCB mounting receptacle, with a 6.5mm phone jack socket built into its centre. The jack socket may be fitted with two or three gold plated contacts (ring, tip and sleeve) and up to three normalising contacts. Two versions are offered, for either vertical or horizontal PCB mounting, both with mechanical dimensions compatible with Neutrik K-Series, Cannon XLB-Series and Switchcraft PQG-Series connectors.

The 6.5mm jack component of the connector employs Neutrik's retention spring element, completely separate from the electrical contacts. This makes it possible to hard gold plate not only the XLR contacts, but the jack contacts as well, for maximum electrical signal integrity. The very low capacitance between contacts (3pF for the XLR, 5pF for the jack) is said to make this connector ideal for digital audio applications.

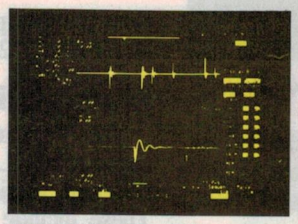
For further information circle 244 on the reader service coupon or contact Amber Technology, 25 Skyline Place, Frenchs Forest 2086; phone (02) 975 1211.

Surface mount PLCC sockets

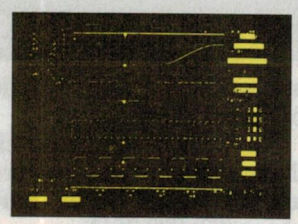


Preci-Dip of Switzerland has introduced a new range of improved surface mount PLCC sockets. The Series 540 PLCC sockets are optimised for surface mount technology, and designed to accept JEDEC MO 047 type plastic leaded chip carrier packages.

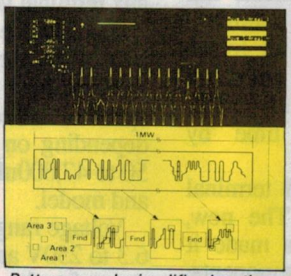
They have polarising features for both socket and carrier insertion. Contacts of highly reliable design hold the carrier safely in place by positive spring action. Their main features are: low profile, only 4.47mm high; open frame allows visual inspection of solder points; socket footprint is the same as the device;



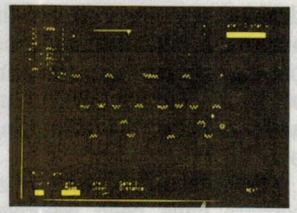
Sequential storage divides memory into blocks so data acquisition never fails even when triggered frequently. Display data captured prior to trigger.



Serial & Parallel Pattern triggering allows triggering when timing coincides or data strings occur in observed waveforms. View information before trigger too!



Pattern search simplifies location of known waveform patterns.



Multi-gate trigger checks validity of trigger point – ensures that only the required signals are observed.

Yokogawa DL2240 offers very large acquisition memory, high sampling speed, and features...

- 1 Mbyte per channel memory
- 400 MS/sec (2 channel single shot)
- 4 full function channels
- Glitch, pattern and multigate enhanced trigger
- FFT, Histogram and advanced math functions
- Sequential event store
- 3.5 inch floppy drive
- GPIB PC interface standard, optional printer

The DL2240 forms part of a range of sophisticated new oscilloscopes from Yokogawa. Call for detailed brochures.



YOKOGAWA

Yokogawa Australia Pty Ltd

A.C.N. 003 888 364

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Queensland	L E Boughen	(07) 369 1277
S. Australia	Trio Electrix	(08) 212 6235
W. Australia	Leda Electronics	(09) 361 7821
Tasmania	Meacon Systems	(002) 44 7575
Auckland N. Z.	N E I	(AKL) 64 2732
Specialist Reps	Tech Fast	(02) 988 3865
	A.T.E.	(03) 543 8041

NEW PRODUCTS

and specially designed to allow infra-red or vapour phase soldering.

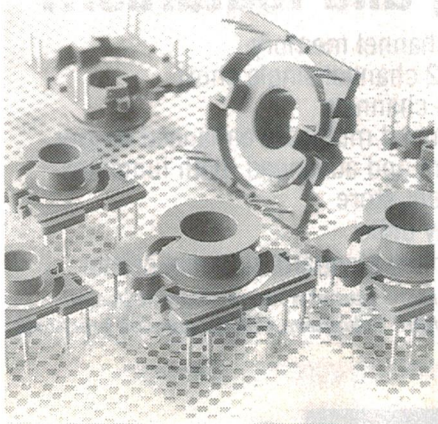
For further information circle 246 on the reader service coupon or contact Veltek, 18 Harker Street, Burwood 3125; phone (03) 808 7511.

Heat-resistant pin coil formers

Siemens Matsushita Components has developed a pin coil for the optimised automatic machine production of ferrite pot-core inductors. It can withstand soldering temperatures of up to 450°C, and reduces manufacturing time by over 50%.

Until now coil formers and terminal carriers have been separate. The new, more heat-resistant plastic has made it possible to combine these components. This eliminates an entire manufacturing step. Now, automatic winding machines with a subsequent soldering station can carry out all the tasks in a single fully automated step. In addition, the new design makes the coil former considerably more compact.

For further information circle 245 on the reader service coupon or contact Siemens Components, 544 Church Street, Richmond 3121; phone (03) 420 7716.



Electrolytic caps

The Punsumi range of electrolytic capacitors (UL approved) comes in many different versions, sizes and capacities. These include low and medium general purpose, medium to high voltage radial capacitors, compact GPs, long life radial capacitors, non-polar miniaturised low profile, PCB mounting and miniaturised aux terminal versions.

Capacitance tolerance for the major part of the range is +/-20%, while some versions have additional capacity to suit specific needs. Capacitance range, depending on model, varies from under 50 to 47,000uF, depending on application and model.

Voltage range extends from 3.5 to 10V, 6.3 to 250V and 10 to 450V. Temperature range for the majority of units is -40 to +85°C, while the 105 model range is extended to -40 to 105°C.

For further information circle 247 on the reader service coupon or contact Passive Electronic Distributors, 14 Queen Street, Nunawading 3131; phone (03) 873 4722.

Surface mount quartz crystal

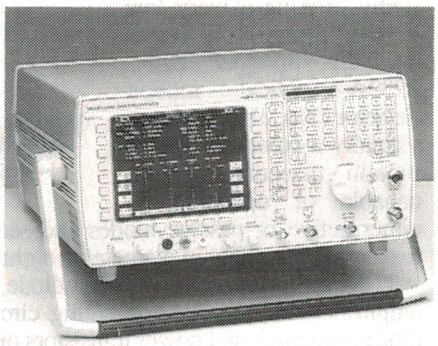
Quartz crystals have been used to control transmitters and receiver frequencies for over half a century.

Now AVX/Kyocera has introduced a real surface mount package with its KS309 range. With their low power consumption, the crystals are suitable for use with CMOS ICs, timing applications, servo controls, analog and digital devices and microprocessors. The packages are reflow solderable at 230°C or more, have low power consumption, and a frequency range from 32kHz to 154kHz.

For further information circle 248 on the reader service coupon or contact ACD, PO Box 139, Bayswater 3153; phone (03) 762 7644.

TEST & MEASUREMENT

High performance radio test sets



Marconi Instruments has launched a major new family of high performance radio communications test sets with the introduction of the model 2965.

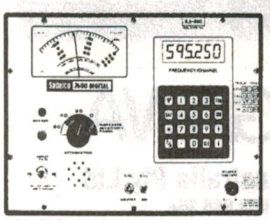
The new lightweight 2965 incorporates a high quality synthesised signal source covering 100kHz to 1GHz, with output power to a high +13dBm.

The unit offers production grade power meter accuracy from 1mW to 150mW, with digital readouts of all parameters and very high speed analog bar charts for peaking adjustments.

A major standard feature of the 2965 is the incorporation of a high performance full span spectrum analyser, with high sensitivity, high resolution and 80dB dynamic range. A precision tracking generator is incorporated as standard, allowing filters/diplexers to be quickly and accurately tuned, and an offset facility allows easy mixer testing.

There is a second 40kHz high speed spectrum analyser for audio signals, and the 2965 incorporates three low distortion modulation/audio oscillators covering from DC to 100kHz. The digital storage scope covers to 500kHz and has comprehensive trigger, zoom and anti-aliasing facilities.

TWO MORE TOP PRODUCTS FROM MMT



Sadelco®

Model 7600 (6.5 to 890 MHz)
± 1.0dB Flatness
Auto Crystal Calibrator
Electronic Relay Attenuator
Microprocessor Correction Circuits
Full gasket for faceplate
Sealed Jacks, switches & keypad
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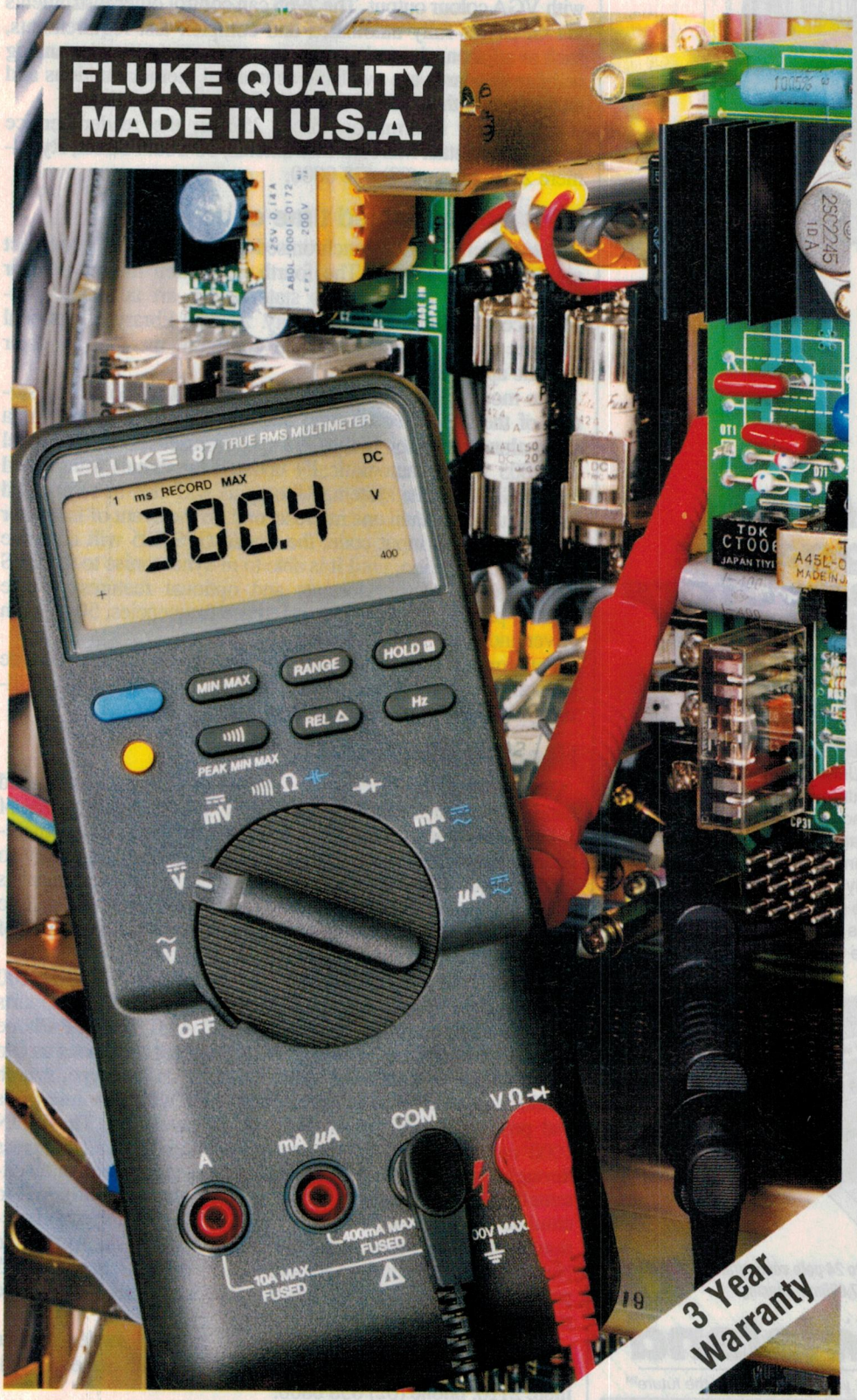
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NEW PRODUCTS

The new tester offers a PC-compatible memory card facility with powerful autorun programming and a high resolution CRT with VGA colour output. The 2965 can control other instruments via GPIB for fully automated and complex test requirements, such as adjacent channel power measurements. All major analog cellular standards are available as internal memory options and an upgrade path for GSM testing will soon be available.

For further information circle 252 on the reader service coupon or contact Marconi Instruments, 38 South Street, Rydalmere 2116; phone (02) 638 0800.

GPS synchronised time code unit

The model GPS-805 synchronised time code unit is a compact rack-mounted package. The fourth generation microprocessor based modular design offers state of the art accuracy, convenience, flexibility and reliability. A large library of optional features enables users to custom configure the unit for their specific applications.

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For further information circle 251 on the reader service coupon or contact Rohde & Schwarz, 63 Parramatta Road, Silverwater 2141; phone (02) 748 0155.

Hand held ISDN tester

The new ISDN 1000 from Digitech Industries is a rugged hand held tester for basic rate 'U' and 'S/T' interface points of ISDN lines. The tester is ideal for installing, testing and maintaining ISDN lines requiring GO-NOGO testing. Its ability to autoconfigure to the line, and perform other automatic functions such as Line ID and insertion loss tests with only one or two keystrokes, makes the ISDN 1000 easy to use by taking much of the inherent complexity out of ISDN line testing.

It is self contained and battery operated, measuring 230 x 100 x 50mm and weighing under 1.4kg. The tester currently supports up to five different line types including T, AMI, 2B1Q, P-Phone (EBS) and POTS, and as many ISDN protocol variations as can be supported in memory. It autoconfigures to line type, switch vendor and protocol, and may be upgraded with new interfaces and protocol variations as they become available. The ISDN 1000 can place and receive calls, and monitor call progress through clear LCD messages, an integral speakerphone or an externally attached handset. The tester can also be configured to emulate an NTI. It is also programmed to perform special functions such as automatic access to AT&T BRITL tests, Automatic Number Identification (ANI and ANA) and D channel X.25 packet tests. Line quality, performance and line loss can be measured and reported.

For further information circle 270 on the reader service coupon or contact Marconi Instruments, 38 South Street, Rydalmere 2116; phone (02) 638 0800.

Digital insulation tester

Yokogawa has announced the release of its new 2426 digital insulation tester, which offers digital and analog bar-

graph displays and features 'one-touch' measurement with an audible alarm to allow fast repetitive testing.

The 2426 analog bar-graph display operates at a sampling rate of 20 times/sec to achieve a rapid measurement indication, while the digital readout provides a stable 3.5-digits resolution for making precise measurements. A moving-average filtering technique is used, to reduce flickering of the last digit of the digital display. Two models are available, covering test voltages from 100V up to 1000V, and resistance ranges from 20M up to 2000M, full scale. Standard accessories include ground and line probes, and soft carrying case.

For further information circle 253 on the reader service coupon or contact Yokogawa Australia, 25-27 Paul Street North, North Ryde 2113; phone (02) 805 0699.

Low cost DSO card

The Compuscope LITE is a high speed data acquisition card for the PC-XT/AT, for capture and storage of analog data, providing high speed digital storage at low cost.

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For further information circle 256 on the reader service coupon or contact Boston Technology, PO Box 415, Milsons Point 2061; phone (03) 955 4765.

FM comms interceptor

The Optoelectronics model R10 FM Communications Interceptor was conceived initially for the testing market, but will have significant impact in the security, counter-surveillance and recreational communications monitoring markets.

Any FM signal from 30MHz to over 2GHz can be intercepted, without any gaps in coverage. The R10 measures deviation (wide and narrow band), relative field strength, signalling tones, (CTCSS), and any measurement requiring demodulated FM. The R10 is suitable for testing VHF, UHF and cellular transmitters, and can be a low cost highly portable substitute for a service monitor in some applications.

For more information circle 264 on the reader service coupon or contact Optoelectronics, 5821NE 14th Avenue, Fort Lauderdale, Florida FL 33334; phone (305) 771 2050.

TOOLS

SMD tweezers

The SAI-644 SMTweezer is a versatile, static dissipative handpiece for use with the SA-1000 modular soldering system from OK Industries. The tweezer is interchangeable with the SA-1000 soldering irons and has an RTD temperature control module. Temperatures range from 245°C to 425°C. Fourteen interchangeable SMT tips are available in a variety of styles from 0.5mm (0.020") widths for small component removal to 18mm (0.70") widths for chip removal.

For further information circle 258 on the reader service coupon or contact Electronic Development Sales, PO Box 822, Lane Cove 2066; phone (02) 418 6999.

Hot air desolder

Scope Laboratories has released the latest model of its HS600 hot air desolder station. This latest surface mount desolder system, developed by HOZAN of Japan, features an improved air flow control valve. Both air temperature and air velocity settings can be rapidly re-established to suit the range of multi-jet nozzles required in your plant.

For further information circle 262 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042: phone (03) 338 1566.

New Scope solder stations

A second range of professional solder stations has been released by Scope Laboratories, to complement its well established ETC 60W and 30W series. This is the new PX-1 series, designed for mainstream high reliability soldering. Noticeable features include the latest Japanese element technology, and one model includes a three colour temperature read out.

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NEW PRODUCTS

The existing ETC range of multi-option stations will continue to aim at technicians who have specialised needs. These options can include 60W, 30W or dual configurations, 'time-out' or automatic switch-off, as well as floating earth or low impedance earth choices.

For further information circle 266 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566.

Air band transceiver

Icom's popular air band transceiver, the IC-A20, has been updated and is now released as the IC-A20MKII. The model has DOTC approval for sale in Australia.

The new model has an increased memory capacity, from 16 to 20 channels, for storage of vital frequencies like those for the tower, ground control, company radio, VOR and others.

Also, its navigation function now includes DVOR, which indicates the locations of the aircraft by receiving signals from two VOR stations.

Also available is CDI (Course Deviation Indicator), which lets you know the deviation from desired course, along with ABSS (Automatic Bearing Set System) to allow you to adjust to the exact bearing immediately.

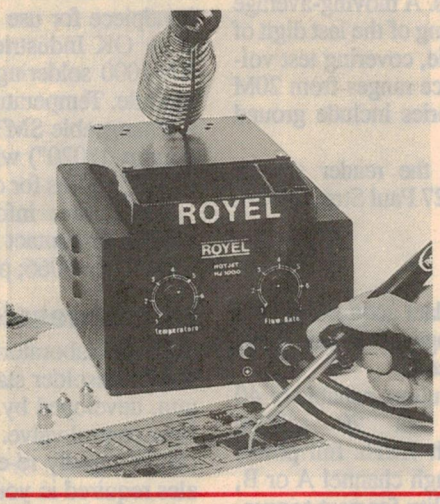
Programmed scan repeatedly searches stations in a desired frequency range, while memory scan checks frequencies sequentially that have been stored into the memory channels.

Other features include immediate 121.5MHz access in emergencies, high sensitivity of 1uV for 6dB S/N, automatic gain control and noise limiting, and 5W (PEP) of output power. The RRP is $795 plus tax.

For further information circle 260 on the reader service coupon or contact Icom Australia, 7 Duke Street, Windsor 3181; phone (03) 529 7582.

Hot gas reflow system

The HJ1000 is a hot gas reflow system for surface mounted component (SMC) reflow operations. It comprises a hot gas pencil (Cat No.HJ100) and a power unit, incorporating a variable speed controlled pressure/ vacuum pump and gas temperature regulator. A foot switch for on/off control of the heating element is available as an option. Gas jet temperatures from ambient to 400°C can be achieved with variable flow rates from 0.25 to 4L per minute. The unit usually employs hot air for reflow operations, but can function with inert nitrogen gas for reducing oxidation during reflow operations.



The system is intended to be used in conjunction with the Royel ramp-up preheat unit (Cat No. PH9000), for replacement of surface mount packages on printed circuits with the same degree of process control as in the original manufacture of the circuit.

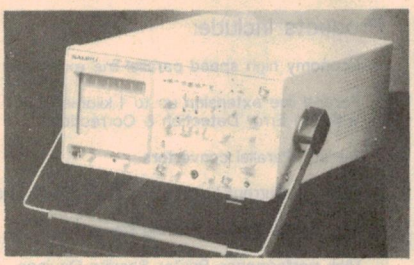
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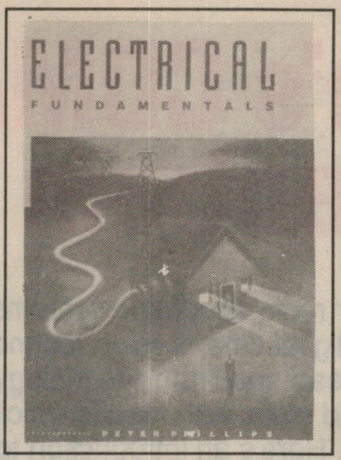
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READER INFO NO. 35

Cellular radio technology:

Qualcomm's CDMA Spread Spectrum

Just as many of the world's cellular radio telephone systems began changing over from frequency-division analog FM technology to digital time-division technology, US firm Qualcomm announced a third system based on military spread-spectrum technology. Since then, the firm's CDMA Spread Spectrum has undergone many field tests, with results which many people believe show it may well be the 'ultimate' cellular technology. Here's an introduction to CDMA and how it works...

by JIM DAVIS

A recent article in *Electronics Australia* (September and October 1992) described GSM, the new cellular mobile phone system being trialled by Telecom Australia. GSM uses TDMA (time division multiple access) techniques, and will eventually replace the older AMPS cellular system which uses FM modulation. Many people, however, believe that GSM is only a temporary solution to the problem of overcrowding of the limited frequency bands allocated to cellular mobile telephone network users.

In 1990, Qualcomm Incorporated, a US company based in California, surprised many people in telecommunications by demonstrating a digital radio technology called *code division multiple access* (or CDMA) *Spread Spectrum*, as a competitor to GSM. Many observers however see Spread Spectrum as the basis of future third generation systems, which will replace GSM as it too gets congested.

CDMA Spread Spectrum is actually not a new technology. It has been used by the military for secure communications since World War II, and is also used today for satellite communications and by the Global Positioning System, GPS.

Due to the complexity of CDMA equipment, most people believed that CDMA was unsuitable for large scale domestic use — until Qualcomm made the surprise announcement that CDMA handsets could be assembled using four ASICs (Application Specific ICs), and that other problems could also be overcome.

Using CDMA, Qualcomm predicts that 15 to 20 times as many mobile subscribers will be able to use a given bandwidth than is the case with AMPS.

Qualcomm has built some CDMA cellular radio equipment and these have been used, or are about to be used, in trials in the US involving phone companies Nynex, PacTel, Bell Atlantic and Ameritech, who serve the New York, California, US East Coast and Chicago areas. CDMA has also been trialled by the German Deutsche Bundespost Telekom, and Korea has committed itself to jumping directly to CDMA. Before we look at CDMA, however, we need to briefly review both AMPS and GSM.

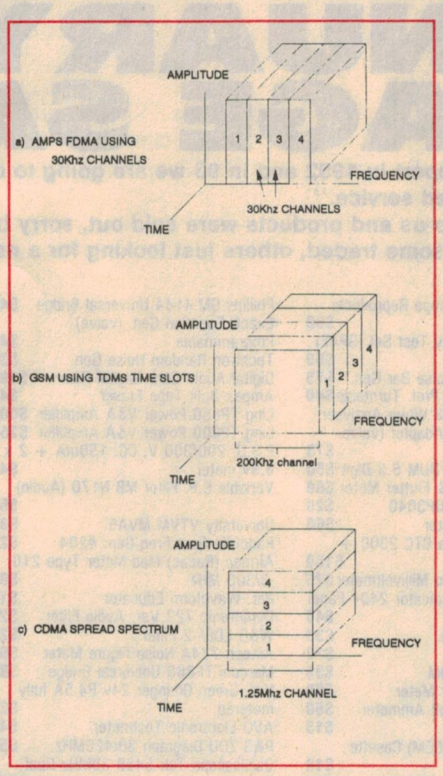


Fig.1: A comparison of the way that the AMPS, GSM and CDMA systems provide multiple channels.

AMPS, or Advanced Mobile Phone System, allocates each telephone call exclusive use of a 30kHz FM frequency channel for the duration of the call. See Fig.1a, in which four different 30kHz AMPS channels are shown.

The digital GSM system however, which uses 200kHz channels and TDMA to fit eight simultaneous calls into a single radio channel, gives each user a specific time slot to transmit and receive voice. This is shown in Fig.1b. Thus, with AMPS and GSM, each user is given either a specific frequency or a specific time slot for his exclusive use during a cellular mobile phone call.

With the Qualcomm CDMA Spread Spectrum method, each caller transmits using a bandwidth of 1.25MHz. If each mobile station were to have exclusive use of a 1.25MHz band, there would not be enough room in the available radio spectrum for many telephone calls. In order to increase the possible number of calls, Qualcomm allows many users simultaneous access to the same frequency band, with each caller transmitting over all the other callers using that band (Fig.1c).

Although conventional wisdom would lead us to believe that many callers simultaneously transmitting on the same frequency would lead to a lot of unintelligible calls, the use of CDMA allows a receiver to extract from the apparent jumble of calls only the call destined for him.

Before we go on to discuss the radio spectrum usage of CDMA, we need first to look at the method CDMA uses to transmit digital data. For ease of



understanding, I will explain CDMA Spread Spectrum using a simplified spreading code that takes only the binary values +1 or -1.

Qualcomm actually uses a more complex spreading arrangement involving QPSK (Quaternary Phase Shift Keying) to gain even higher spectrum efficiency, but the basics of CDMA Spread Spectrum can be understood more easily using this binary-valued spreading code.

Fig.2a shows the digital data that is to be transmitted, while Fig.2b shows a much faster rate and binary valued 'spreading code'. The correct term for the spreading code is the 'chip sequence'. The word 'chip sequence' was chosen because the spreading code is used to 'chip away' at the data to be transmitted, to give a signal with a much higher bit rate.

The signal to be transmitted is formed by multiplying together the digital data in Fig.2a and the spreading code in Fig.2b. The resulting signal to be transmitted is shown in Fig.2c. Thus, the spreading action causes each user's signal to be 'spread' throughout the available 1.25MHz bandwidth — as well as adding a digital 'signature' to the transmitted signal, which allows it to be recognised at the receiver.

At the receiver, the signal is picked up and converted back to the original data by multiplying a second time by the spreading code.

To realise how the original data is extracted from the received signal, notice that because the spreading code only takes the values +1 and -1, if the spreading sequence is multiplied by itself we get the value 1 at all times. That is:

1*1 = 1 and -1*-1 = 1

Thus, by multiplying the data to be transmitted by the spreading code, first at the transmitter and then a second time at the receiver, the original data can be recovered. Of course in order to 'de-spread' the received signal, the receiver must know the spreading code used by the transmitter.

Also, because the spreading code is effectively random, it is important that both the transmitter and the receiver be synchronised so that the de-spreading process can occur correctly. In order for the transmitter and receiver to be synchronised, the transmitter sends out a pilot signal that all receivers in the vicinity can lock on to for synchronisation.

Although in Fig.2 we used a spreading code with a bit rate (or chip rate) four times faster than the data rate, Qualcomm actually uses a spreading code that is 128 times faster than the data rate of 9600k bits/second.

Also, although I said that the spreading code is effectively random, it is actually *pseudo-random* and repeats itself every 32,768 bits.

QPSK vs binary spreading

In order to provide a simplified explanation of CDMA, the arithmetic in this article assumes a binary-valued spreading code rather than the QPSK (quaternary phase shift keying) code used by Qualcomm. As such, the power spectrum density bandwidth for the binary spreading code would be (from Fig.3):

9600*128*2 = 2.46MHz.

By using QPSK and other advanced techniques, Qualcomm has increased spectrum efficiency to allow a bandwidth of only 1.25MHz. The principles however are the same in both cases.

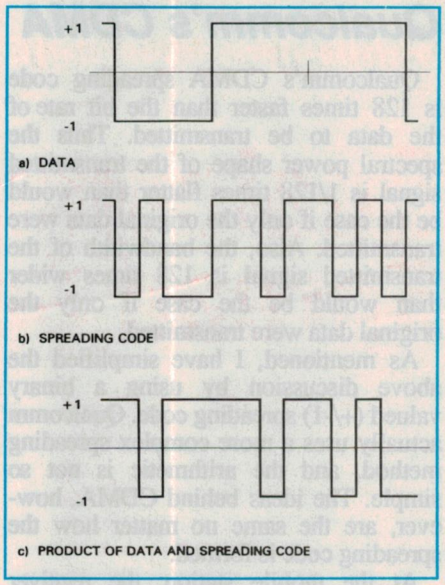


Fig.2: Spread Spectrum uses a pseudo-random 'spreading code' to widen the data's bandwidth.

Spreading it thinly

Now that we know what the spreading code is and how it is used, we are in a position to look at the radio signal transmitted by a CDMA Spread Spectrum station. To understand the CDMA radio spectrum, we need to understand how digital signals are transmitted in a frequency band. Fig.3a shows digital data with a bit rate of R bits/second, together with the power spectrum density of the transmitted signal. As a comparison, Fig.3b shows the power spectrum density of a spreading code with a bit rate four times faster than the data's bit rate.

We can see from Fig.3a that a square wave signal of amplitude +/-A and a bit rate of R bits/second will produce a signal of frequency and amplitude distribution as shown. For a square wave to be transmitted accurately, the complete frequency distribution also shown in Fig.3a will need to be transmitted; to save bandwidth, however, a frequency band, say, only 2R hertz wide can be used with little resulting distortion of the received signal.

If we look at the transmitted radio frequency spectrum of the spreading code (Fig.3b), we see that increasing the data rate by a factor of four has caused the *amplitude* of the resulting radio signal to be only a quarter of the original value. At the same time, the *bandwidth* necessary to transmit the spreading code has *increased* four times, compared to transmitting the data alone.

In effect, by increasing the bit rate of the transmitted signal we squash the amplitude and increase the bandwidth of the radio signal being transmitted.

Qualcomm's CDMA

Qualcomm's CDMA spreading code is 128 times faster than the bit rate of the data to be transmitted. Thus the spectral power shape of the transmitted signal is 1/128 times flatter than would be the case if only the original data were transmitted. Also, the bandwidth of the transmitted signal is 128 times wider than would be the case if only the original data were transmitted.

As mentioned, I have simplified the above discussion by using a binary valued (+/-1) spreading code. Qualcomm actually uses a more complex spreading method, and the arithmetic is not so simple. The ideas behind CDMA, however, are the same no matter how the spreading code is formed.

At the mobile station, the receiver detects all the CDMA radio signals that are being transmitted on the 1.25MHz band. This signal is shown in Fig.4. If the receiver now multiplies the signal by a de-spreading code which is identical to the original spreading code, the data intended for that receiver can be extracted from the apparent jumble of radio signals that were also detected.

Because each of the transmissions on the 1.25MHz band uses a unique spreading code sequence, only the incoming signal destined for that receiver is able to be 'de-spread' using the receiver's spreading code. None of the other transmissions will be de-spread. As with AMPS and GSM, the transmit and receive frequencies for CDMA are 45MHz apart, and will likely be in the same frequency range as is used today for cellular radio in the US: from 824 to 894MHz.

Pros and cons

With cellular radio, any geographic area in which mobile service is to be offered is divided into cells, with the area being divided into groups of, say, seven cells. Both AMPS and GSM have the restriction that a frequency used in one cell cannot be used again in an adjacent cell. One of the reasons that CDMA gives a capacity increase over AMPS in the number of possible simultaneous calls, is that each cell can use exactly the same frequencies as all other cells, giving an immediate six-fold increase in capacity, using the seven cell grouping.

Also, with both AMPS and GSM, both a transmit and a receive channel are allocated exclusively to every caller. Because only one person speaks at a time during a voice call, at least half the frequency channels are not used simultaneously during a voice call. CDMA exploits this by not allocating bands exclusively to users, and channel capacity can be increased by up to a further factor of two.

Because GSM uses a specified number of channels, every caller gets exclusive use of a radio channel. As a result all GSM callers should get the same speech quality; but during congestion, some new callers may not be able to get a connection. With CDMA there is no upper limit to the number of simultaneous calls possible, but every new call reduces the quality of all other calls. As a result, during congestion, CDMA voice quality will be poorer than during off-peak hours — encouraging non-essential callers to remain off the network.

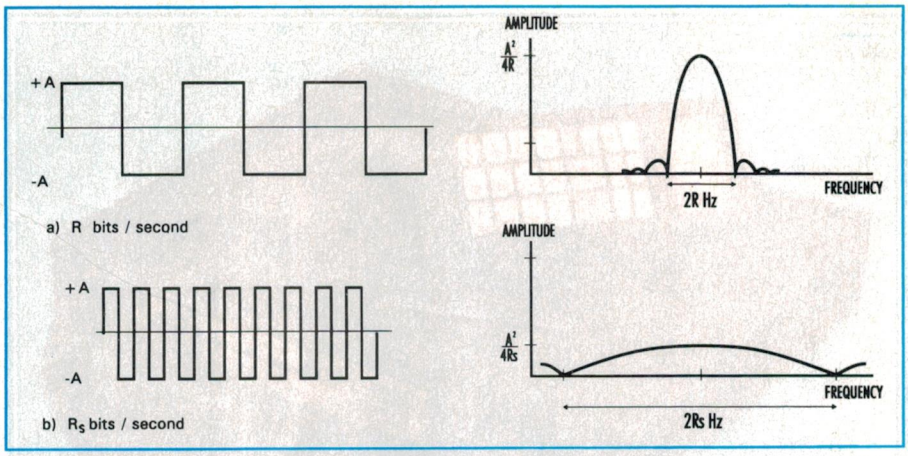


Fig.3: A data signal of R bits per second has a bandwidth of 2R hertz, and an amplitude as shown in (a). In contrast, a spreading signal of Rs (4R) bps has four times the bandwidth but one quarter the amplitude (b).

Because of the increasing noise level during periods of congestion, CDMA is more suitable for voice than for data, although with advanced error-correcting techniques this problem can be minimised. Another big advantage of CDMA is that it is less susceptible to multi-path fading than GSM — an important factor in built-up areas.

Although Qualcomm claims that CDMA will give a 15 to 20-fold capacity improvement over AMPS, many people believe that these predictions are optimistic. Independent investigations however show that CDMA may only give a 10-fold capacity improvement over AMPS compared to the three-fold capacity improvement the present GSM gives over AMPS —and the six-fold improvement future GSM systems will give. Also, GSM is a mature technology while CDMA, for large scale domestic use, is at best still on the drawing board with not all the problems having been solved.

Because GSM can be introduced into the Australian network using some of the facilities of the older AMPS, its introduction will be relatively painless. If CDMA were to be introduced, however, its introduction would be much more expensive and difficult to implement due to the revolutionary nature of the technology.

Whether all of Qualcomm's claims for CDMA can be realised or not, CDMA Spread Spectrum is causing considerable stir amongst cellular mobile network equipment vendors and operators. Whatever the outcome of CDMA as a competitor to GSM, the widespread domestic use of CDMA Spread Spectrum in future third-generation cellular mobile systems seems assured. These future third generation systems will almost certainly use a combination of CDMA, FDMA and TDMA techniques. ❖

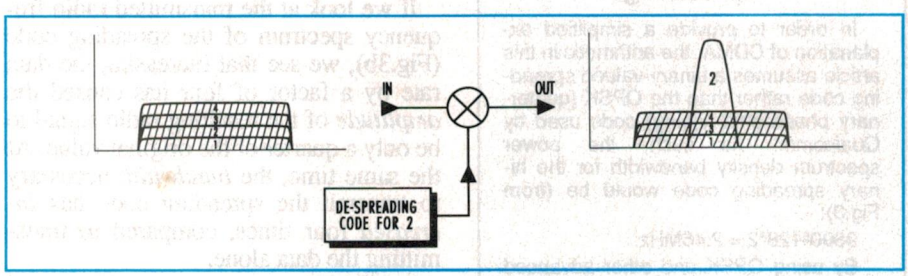


Fig.4: To decode any particular CDMA Spread Spectrum channel, the composite received signal is multiplied with that channel's de-spreading code. This causes the signal for that channel to be restored to its original bandwidth.

Perfect Measurements



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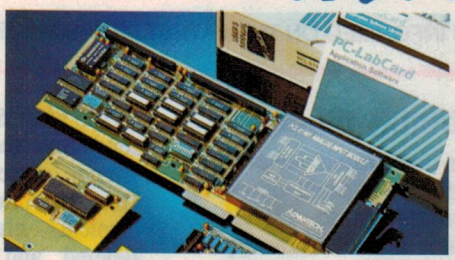
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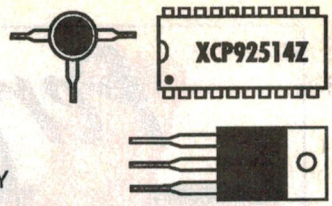
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READER INFO NO. 38

Solid State Update



KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

15GHz Schottky diodes

Siemens has introduced state of the art Schottky diodes capable of operating at frequencies up to 15GHz for mixer, modulator and detector applications in satellite systems, mobile communication, modules, test and measurement equipment.

The BAT 14, 15, 62, 63, 68 and 114 series are low, medium and high barrier diodes in single, dual and quad configuration. Especially unusual is the quad device, configured as a 'cross-over ring'. This achieves improved performance in isolation over standard ring configurations. All are packaged in industry standard SOT 123, SOT 23 and SOT 143, which are all surface mountable.

For further details circle 272 on the reader service coupon or contact Siemens Advanced Information Products, 544 Church Street, Richmond 3121; phone (03) 420 7716.

Zero-crossing triac driver

Motorola has introduced the MOC6800 series of zero-crossing triac driver optocouplers, developed specifically for industrial control applications. This series of devices feature expanded operating temperature to 100°C, global regulatory approval for voltage isolation, and transient noise immunity specifications.

The MOC6005 (5mA LED trigger current) and the MOC6010 (10mA LED trigger current) have been developed from the circuit designer's perspective. Typical characteristics have been deleted and replaced with minimum and maximum specifications. This allows the designer to design around worst case situations.

Typical temperature characteristics have also been replaced with 'design limits', which eliminate the need for temperature compensation and characterisation. Applications related parameters such as static dV/dt is rated at a minimum of 2.5kV/us, while the IEEE 472 1.2MHz decaying surge withstand requirement 2.5kV is also exceeded.

For further information circle 273 on the reader service coupon or contact Veltek, 18 Harker Street, Burwood 3125; phone (03) 808 7511.

Overvoltage protection for multiplexers

With the release of the DG458 and DG459, Siliconix has added two new low cost multiplexers with overvoltage protection. Both the DG458 and DG459 can withstand overvoltage inputs up to +/-35V.

They are designed for use in PC-controlled analog data acquisition systems, industrial controllers, test systems and any similar systems where it is necessary to multiplex external analog sources to A/D converters. These new multiplexers are pin-for-pin compatible with the HI508A/509A and the MAX358/359.

The DG458 is an eight channel single-ended multiplexer, and the DG459 is a differential four channel multiplexer. Both are built on Siliconix's silicon-gate CMOS process and offer fast switching speed (250ns maximum) low power consumption (3mW), and low on-resistance (1.8k maximum).

Overvoltage protection to +/-35V assures that the devices will not malfunction or be damaged if the analog signal applied to the switch terminal exceeds the power supply rails. No extra protection circuitry is needed. The DG458 and DG459 are also latchproof, which means there will be no loss of switch control or damage to the switches during fault conditions.

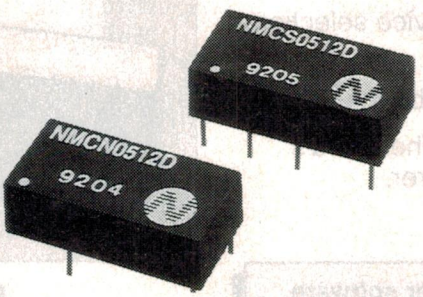
For further information circle 274 on the reader service coupon or contact IRH Components, 1-5 Carter Street, Lidcombe 2141; phone (02) 364 1766.

DC-DC converters in DIL packages

Newport Components' NMCN and NMCS ranges of 300 to 700mW single and dual isolated DC-DC converters are designed to be pin-compatible with the Micro Gisco 1CCN and 1CS series. They also take up less space on the PCB.

The two series are available in DIP style and require only 2.0 square cm of board space; the package size is similar to that of Newport's popular NMA device. The units operate from 5, 12 and 24 volts input.

The NMCN provides isolated single output voltages of 5V, 12V and 15V. It is isolated to 1000V DC and its total delivered power ranges from 300mW to 500mW. The dual output NMCS series is also isolated 1000V DC and provides outputs of +12V. Its total delivered power



is 700mW, all of which may be drawn from one output pin.

No heatsinks are needed for the rated performance and the operating temperature range is -25° to 80°C.

For further information circle 271 on the reader service coupon or contact Alpha Kilo Services, PO Box 180, Lane Cove 2066; phone (02) 428 3122.

Transistor for electric cars

Toshiba Corporation in Tokyo has announced the introduction of two new Insulated Gate Bipolar Transistors (IGBT), suitable for use in electric cars.

Electric cars use direct current (DC) from the battery to power a motor. DC is converted into alternating current (AC), which is more suitable for driving a motor, and rotation speed is controlled by changing the frequency of the AC.

Current electric cards use many low capacity transistors to make inverter circuits that can cope with voltages vetween 200V and 300V and large current flows from the battery. IGBTs are suitable devices for this kind of application, particularly as they suffer little power loss during DC/AC conversion.

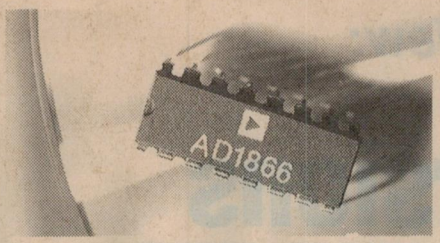
The new models are dual type IGBTs, consisting of two IGBT modules able to handle up to 600V and 400A. The MG400J2YS40 is a high speed switching type and the MG400J2YS45 has the advantage of low loss.

The dual structure of the new IGBTs contribute to the simplification of the circuitry of electric cars. With their lower inner inductance, the power distortion which occurs in current conversion,

Single supply 16-bit stereo audio DAC

Analog Devices' newest SOUNDPORT family member is the AD1866 complete stereo 16-bit PCM audio DAC, which operates from a single +5V supply for portable, low power and computer audio (multimedia) applications. The AD1866 requires few external components to achieve rated performance, thereby reducing system complexity and cost.

This complete IC comprises two independent precision references, output amplifiers and 16-bit converters. DC-bias pins which position the output signal at 2.5V midscale (1.5 to 3.5V swing) eliminate the need for false-ground circuitry.



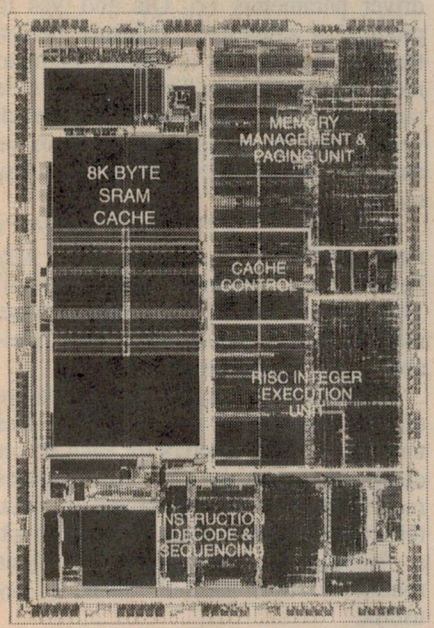
Key specifications are: THD+N (measured at 990.5Hz), at 0dB 0.005%, rising at -60dB to 2%; SNR, 95dB; channel separation, 115dB; and power dissipation, 50mW.

Applications for the AD1866 include automotive, portable, and low power digital audio playback systems, PC add-on boards, and multimedia workstations.

For further information circle 276 on the reader service coupon or contact NSD Australia, Locked Bag 9, Box Hill 3128; phone (03) 890 0970.

has been halved, reducing the switching noise that can degrade the performance of other circuits. Less inner electrical resistance also encourages a smaller package.

33MHz version of Intel 486SX uP



Intel Australia has released a 33MHz version of its Intel486SX microprocessor, adding to its line of 16, 20 and 25MHz 486SX CPUs. In addition, Intel announced a new speed-doubling OverDrive Processor for the 33MHz version.

The 33MHz Intel486SX CPU offers up to 32% performance increase over the 25MHz 486SX CPU, and twice the performance of the 33MHz 386DX. It delivers 27 Dhrystone V1.1 MIPS and a SPECint92 rating of 19.5.

The 486SX microprocessor is 100% compatible with the Intel486DX and 486DX2 CPUs and all members of the 386 microprocessor family.

The Intel OverDrive Processors are single-chip performance boosters that speed up Intel486 CPU-based system performance by up to 70%.

This OverDrive Processor adds floating point capability to 33MHz 486SX microprocessor-based systems, thus achieving even higher performance gains on math-intensive applications, in addition to doubling the clock speed. The 66MHz OverDrive Processor has a RRP of $1395.

For further information circle 277 on the reader service coupon or contact Intel Australia, PO Box 1486, Dee Why 2099; phone (02) 975 3300.

Viterbi decoders

Qualcomm has announced production of its newest generation of integrated Viterbi decoders for digital communication applications. With 10Mbps operation, the Q1601 is priced comparably to current decoders which run 40 times slower.

Qualcomm's Q1601 Viterbi decoder has been specifically designed for today's cost sensitive, high volume applications, including VSAT networks, Direct Video Broadcast, Direct Audio Broadcast (DAB), Digital Video Reception, Spread Spectrum and Microwave Point-to-Point Systems.

Using the new Viterbi decoder, communication engineers can implement the built in, powerful Forward Error Correction (FEC) with low cost devices for modern digital communication channels at very high data rates.

The Q1601 is a full custom Viterbi system-on-a-chip, which requires no external circuitry to implement Rate 1/2 coding with three bit soft decision symbol inputs. It includes on-chip CCITT V.35 data scrambling, channel bit error rate (BER) monitoring, differential decoding, and automatic synchronisation to BPSK, QPSK and OQPSK modems.

The decoder offers both low power consumption (<0.8W at 10Mbps) and 5.2dB coding gain, and uses a microprocessor interface bus to simplify control.

For further information circle 279 on the reader service coupon or contact Veltek, 18 Harker Street, Burwood 3125; phone (03) 808 7511.

Amiga 4000 uses 68040uP

Motorola's High Performance Microprocessor Division recently announced that its 68040 provides the processing power in Commodore Business Machine's new Amiga 4000 computer, which is designed to meet the demanding graphic and video-processing needs of multimedia computing.

The Amiga 4000 is a full-scale multimedia system, incorporating Commodore's Advanced Graphics Architecture custom coprocessor chipset, which allows users to display and animate graphics in multiple resolutions up to 256,000 colours from a palette of 16.8 million. This array of colours and features brings life-like images and photo-quality colours to any document or presentation.

In addition, the robust processing power of the Motorola 68040 microprocessor ensures that the Amiga 4000 is a high performance, full function computer with the power to execute data-intensive multimedia applications at ease.

Motorola's microprocessors have been integral in the development of the Amiga product line since introduction in 1985.

The 68040 is an advanced single-chip processor incorporating more than 1.2 million transistors. Fabricated with Motorola's high performance complementary metal-oxide semiconductor (HCMOS) process, the 68040 integrates an integer unit, a floating point unit, two memory-management units and two four kilobyte cache memories — one for data and one for instructions.

The two on-chip caches provide high speed temporary storage of information most recently used by the processor. In data-intensive applications, such as those used on the graphically-based Amiga 4000, this allows the processor to work efficiently during the constant flow of information. ❖

CAD software review:

Latest versions of LEAP and LMS

We recently had the chance to check out the current release versions of ATI's popular loudspeaker design and measurement programs: LEAP and LMS. Both offer a host of new capabilities and performance enhancements, making the combined package a very comprehensive platform for loudspeaker design.

by ROB EVANS

The Loudspeaker Enclosure Analysis Program (LEAP) for IBM-compatible PCs first came to our attention in 1989, when Jim Rowe tried out the original version, release 3.1, and noted his impressions in the May issue of *Electronics Australia* with a review aptly titled 'Leap — before you look into speaker enclosures'. In this early version, he found LEAP to be a excellent tool for modelling woofer/enclosure relationships; and as a bonus, Jim gained the reactions of the founder of modern speaker design Mr Neville Thiele, who was also quite impressed as it happens. We've been fortunate enough to use LEAP from that time on.

During this period however, the package has undergone substantial development through a string of updates from the prolific author of LEAP, Chris Strahm — culminating in the current release, version 4.14. In between a series of other audio-related projects (a high-end mixing desk for concert productions, to name one), the productive Mr Strahm has also managed to both develop and substantially upgrade his Loudspeaker Measurement System (LMS) software/hardware package during the same period. Not bad, for one engineer over a four year interval...

For those who might be interested, Chris Strahm's background includes an engineering stint with Hewlett-Packard, consultant work with NASA, and most significantly, extensive involvement in professional sound engineering and large-scale PA systems.

Knowledge of this latter experience gives an insight into some of the unique aspects of LEAP in particular, such as the ability to analyse a number of enclosures in an array and at high power levels. It appears in fact that LEAP was originally conceived as a tool for Chris Strahm's work with live sound systems.

It's also interesting to note that many of the improvements which have been made to both LEAP and LMS appear to have been in direct response to customer requests, rather than based on what ATI or Chris Strahm assume is needed from the next version.

This type of attitude to customer relations should ensure that ATI will continue to prosper in the specialised field of audio software and hardware, which deals with relatively expensive products for a limited number of customers.

LEAP version 4.14

Since the first release of LEAP (version 3.1) was produced way back in 1988 and reviewed by *EA* in 1989, it may be of benefit to recap on the principles and basic features of the program.

In its essential form, LEAP allows the user to enter the appropriate parameters of the driver (speaker) and the enclosure, so that it can develop an internal 'model' of the system for analysis. Then using the number-crunching ability of your PC, it works out what happens over a predetermined frequency range (say 10Hz to 1kHz), and either draws the resulting curves on the screen or sends the response data to an attached printer.

The program can produce a wide variety of curves, such as on-axis sound pressure level (SPL), power SPL, cone excursion, impedance response, and so on — all of which include an associated phase response. It can also store these curves on disk in a 'Design' library, along with a note of which speaker and enclosure data was used to generate the result.

Other basic features include library storage facilities for enclosure and speaker data, with a number of supplied speaker libraries covering popular driver manufacturers such as KEF, SEAS, Vifa, plus many more.

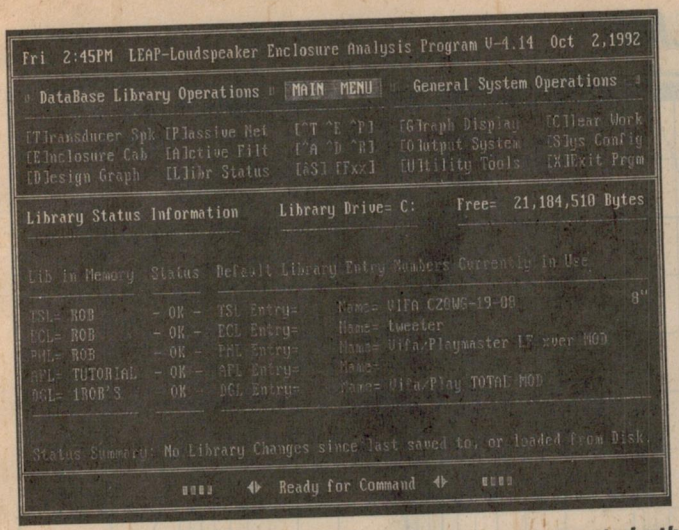
LEAP also offers a very handy 'Quick Cabinet' facility, which uses the basic driver parameters Fo, Qts and Vas to produce a suggested enclosure design that can be used as a starting point to more serious designs. This covers a wide range of cabinet types including sealed, vented and so on, and lives up to its name by producing results in just a few seconds.

According to ATI, one of LEAP's main attributes is that it goes way beyond the original 'small signal' Thiele/Small model, by using a large number of frequency-dependent variables in its analysis routine.

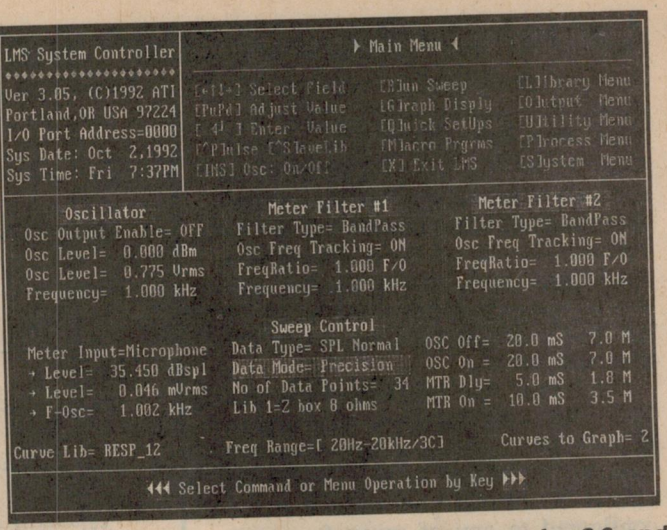
Evidence of this is the complex nature of LEAP's speaker model, which uses more than 15 parameters for each driver entry rather than the three basic figures required by the simpler model. In fact, the Quick Cabinet utility is pretty much a traditional Thiele/Small analysis routine, which in itself of course, is very useful.

While Thiele/Small zealots may prefer to use just the classic analysis provided by Quick Cabinet and a little seat-of-the-pants tuning for their designs, we've found the fully-blown LEAP routine to provide extremely reliable results. This has been used to considerable effect in a number of past *EA* designs.

Note that all of the above features were available in the original release of LEAP (version 3.1), and as you would expect, are retained in the latest version 4.14. But the new release includes a



LEAP's main menu screen. Version 4.1 now supports both active and passive filter network analysis, allowing you to design and evaluate all aspects of a speaker system.



LMS version 3.0 responds much faster than version 2.0, and offers a host of new post-processing utilities. An entirely new 'Process' menu has been added to LMS's main screen.

number of valuable additions and changes, which make the package even more useful for practical speaker design — we're happy to say that the latest features are not simply a bunch of tacked-on bells and whistles to make it *appear* more advanced.

For a start, LEAP now supports both passive and active filter design libraries, and an enhanced analysis routine to suit. So you can now assemble a complete system including the driver, its enclosure, and an active or passive crossover, then then run the analysis which will take all of these factors into account.

When it comes to printing out the results of your work, LEAP now gives you the choice of 8-pin and 24-pin dot-matrix printers, HP or PostScript-standard laser printers, and HPGL-compatible pen plotters. You can also print to a file in any of the above formats, including the Encapsulated PostScript (EPS) standard for transfer to other software such as desktop publishing programs. Note that the original LEAP (release 3.1) would only print to the two types of dot-matrix printers.

The types of curves that LEAP can print and display has also been greatly expanded. While the old version made five performance curves available, LEAP now derives data for no less than 19 different graphs — these include plots for port air velocity, passive and active network transfer function, group delay, off- axis response, and so on.

You can even display, print and export curves showing the sum of more than one 'design', which is ideal for seeing how the various parts of a multi-way system add together, for example.

Another very useful new feature of the updated LEAP is its ability to automatically derive a full list of driver parameters from a pair of impedance curves: one representing the driver's free-air response, and the other showing its characteristics in either a sealed enclosure of a known volume (Delta Compliance method) or with a known mass attached to the cone (the Delta Mass test). These curves would generally be imported from an automatic measuring system (such as LMS) as a simple text file, containing impedance and phase data over a wide frequency range.

The impedance curves could also be manually derived, by using simple test instruments and entering the data into a file using a text editor. However this would be quite a laborious task, and you would probably be better off using the electro-mechanical method that was used for the original version of LEAP. In any case, we've found the automatic file-transfer method (from LMS) to be very convenient and accurate method for deriving a driver's parameters.

LEAP's copy protection scheme has also been changed for the better. The original version was protected using complex software techniques, which allowed only two working copies to be made from the master floppies, and used an encryption method to make sure that the working versions (and the original) could not be duplicated.

The main problem with that scheme is that the program could not be fully backed-up, and in the event of say a hard disk failure, the working copy would be irrevocably lost. As it turned out, this is exactly what happened to the machine that *we* had been using to run LEAP — very annoying...

The new protection system uses a hardware 'dongle', which fits onto the PC's printer port and is interrogated by the software each time you run LEAP. This is a much better system since the software can be backed-up, moved or copied to another machine as you please — it's just that the program will not run unless it finds the correct dongle connected to the printer port. Apparently the dongle will not effect printer operations, by the way.

ATI have expanded LEAP's utility operations as well. Besides the Quick Cabinet and Speaker Parameter Measurement utilities, the system offers routines to help you design crossover and conjugate (impedance correcting) networks, a general impedance calculator and one for solving a driver's Motor Coefficients, and a sophisticated curve averager for processing imported curves.

A recent addition is an *optimising* utility, for both passive and active filter networks. This elaborate routine will automatically adjust a filter's values, so that the proposed speaker system's response curve will change to match that of a definable target curve (within an adjustable error tolerance).

So if LEAP is predicting a rather lumpy response from your basic design — which would include a driver, enclosure and crossover filter — for example, you can tell the optimiser what filter components can be changed and what the target response is over a certain bandwidth, then sit back and let the optimiser re-arrange your filter values...

As it happens, we tend to be rather

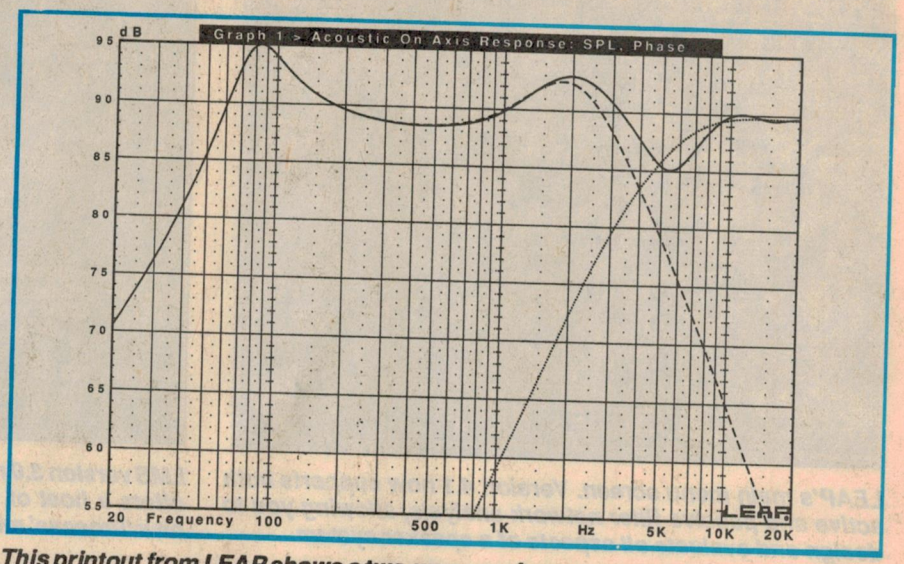
dubious about this type of automatic operation in the *EA* office, since we've seen too many PCB CAD packages make a complete 'pig's breakfast' out of a circuit board during their auto-routing process. In this case however, the LEAP optimiser seems to do a fine job of reaching its goal, without locking itself into an unresolvable situation or coming up with a design featuring wildly impractical values.

Other than that, LEAP can now analyse dual bandpass-type enclosures, cope with conjugate-mounted drivers (two connected face to face), predict the effects of internal port reflections, be configured to any of seven frequency ranges, import and export files in a wide range of formats, plus much more. Whew!

With all of these new features, it's not surprising to find that LEAP version 4.14 is a much larger program in just about every sense. It comes in a compressed format on two 1.2MB floppy disks, occupies around 4MB of your hard disk space (excluding design libraries, which take up about 400KB each), and needs at least 540KB of free conventional memory to run.

If the PC is suitably equipped however, LEAP can use free extended memory for its overlay files (up to 1MB), use a RAM drive as a design library cache, and take advantage of a co-processor for floating-point calculations. All of these techniques help to speed up LEAP's analysis routines and prevent delays while graphics screens are updated. In CAD package terms, it's quite a fast program.

In general, it's safe to say that LEAP has developed into a very sophisticated loudspeaker design package, and can now cope with virtually all of the components and variables involved in contemporary speaker design. ATI's claim that LEAP is becoming the preferred choice of industry professionals around the world may not be far from the mark.



This printout from LEAP shows a two-way speaker system's total response curve (solid line), which was derived from the curves of the individual drivers with associated filter networks (the dashed lines).

LMS version 3.05

ATI's sister program to LEAP is LMS, a software *and* hardware based acoustic measuring system which uses both gated and continuous sinewave signals in conjunction with a calibrated microphone to perform a wide range of audio tests. For those who may not be familiar with LMS, a complete review of LMS version 2.0 was published in the June 1992 issue of *Electronics Australia*, written by yours truly.

As with LEAP, we were most impressed with the capabilities and convenience of LMS, and have been fortunate enough to use it ever since. Even though our review of LMS was really quite recent, there have been a number of software updates from ATI in order to to fix a few minor bugs and to add a number of new facilities; in fact, our current version (3.05) is the tenth update since version 2.0.

Probably the most significant change to LMS has been the general speed of the overall program, which now rockets though the various process functions such as levelling a curve, and runs though the calculations prior to drawing a curve on the screen at a much faster rate. This was a problem with older and slower machines before, where it was time to take a coffee break when LMS was performing almost any task — particularly its start-up routine. In practice, the operating speed of LMS appears to have increased by a factor of around 200% to 300%, which is great news.

The program's macro system — where a string of commands in a text file instructs the software to perform a series of tasks — has also been enhanced, by increasing the number of instructions in its proprietary command language (which is similar to BASIC). This should improve the speed and power of the repetitive tests, such as those used by the manufacturing industry.

The post-processing and utility features available in LMS have also been expanded, by a significant degree. Besides the ability to produce a polar plot from a range of off-axis response curves, LMS now offers a utility to convert a normal magnitude/phase curve (Bode plot) into a *Nyquist* plot which presents the combined data as one continuous trace on a circular grid. This type of plot can be used to make a different range of observations regarding the system's behavior — for active systems such as amplifiers and filters for example, the Nyquist plot can be used to predict the unit's margin of stability.

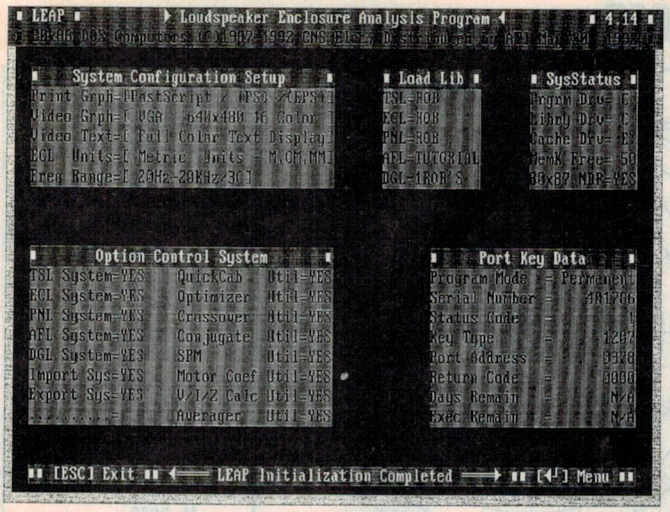
The ability to manipulate response curves for a more convenient result has been improved, as well.

LMS can now *splice* two curves together, which is particularly convenient where a system's low frequency response has to be measured using a different technique to that of the high/mid data — typically, continuous-tone testing for the low, and the gated method for the higher frequencies. In this case the two curves can be seamlessly joined at any nominated frequency (say, around 400Hz), to form a complete plot of the system.

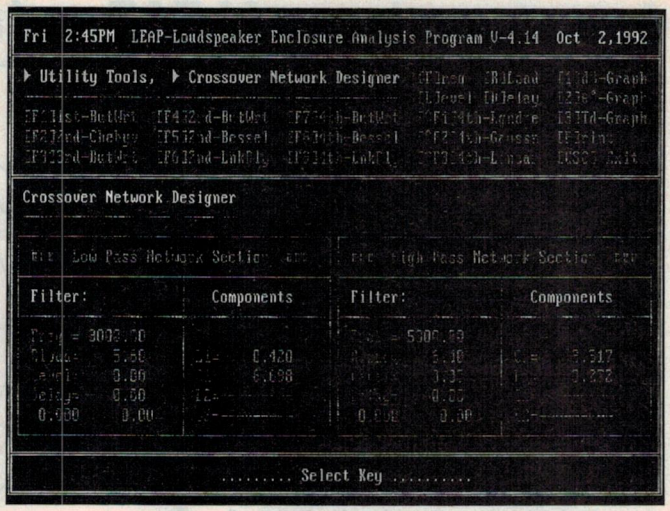
Curves can also have their low or high frequency rolloff slopes manipulated with the *tail correction* facility, which generates a new 'tail' starting at a nominated frequency, and falling with a pre-defined rate.

This is quite helpful where either the data does not cover enough range for some other post-processing function, or where low-level audio interference has corrupted the ends of the rolloff slopes — such as the air conditioning ducts in our own sound lab, which generates substantial energy in the 10Hz to 20Hz region.

Other than that, LMS can perform an



LEAP's initial screen shows the program's current status and configuration. The 'Option Control System' panel shows which LEAP feature is active.The 'Port Key Data' section shows the status of the programmable 'dongle'.



LEAP's crossover network designer will calculate the components needed for a variety of different filter styles, which can then be fine-tuned using the new 'Optimizer' facility.

increased range of mathematical functions on curve data (divide, multiply, square root, etc), add compensating time delays for near-field testing, directly derive driver parameters (although not as accurately as the equivalent system in LEAP, it seems), convert a standard response curve to FFT (Fast Fourier Transform) step and impulse response plots, and combine both SPL and impedance data onto the one curve.

And last but certainly not least, LMS now comes with a 300-odd page ringbound manual, which features a comprehensive index and host of useful application hints. The manual's text is quite clear and concise (even a little too brief at times), and each section is well supported by sample LMS graphs illustrating each concept or feature.

So that's about it for the LMS upgrades. One thing is certainly clear regarding both LMS *and* LEAP: there can't be much idle thumb-twiddling in ATI's software development department...

LMS + LEAP = ?

Since we've been using the combination of LEAP and LMS in the *EA* office for some time now, the package has been rather more thoroughly tested than most other software that comes in for review. It's safe to assume that any limitations and quirks of LEAP and LMS will have appeared during that period.

While there has been a number of (relatively minor) software bugs and operating inconsistencies with both programs, these have mostly been sorted out with the progressive stream of updates sent by ATI. In fact the software revisions have been generated at such a rate that LEAP and LMS users must be feeling a little bewildered — between the two products, it has averaged about one update per month, over the last year or so.

Nevertheless, the revisions have been about more than fixing problems, since just about every new version has added a number of new features or enhancements. The bonus with this sort of rapid-fire software update scheme is that the program's new features are available almost as soon as the code has been written.

When it comes to using LEAP and LMS as an interactive package for developing a speaker system, the various calculations, tests and file exchange operations all seem to occur in a smooth and intuitive manner. While this is helped by the fact that both programs use a similar screen arrangement, command structure, file formats and library manager, there's no doubt that each package has been fine-tuned with the other in mind. In the file *export* section of LMS for example, one of the options for a target directory is LEAP's own *import* directory.

The only significant grumble that we have with LEAP and LMS is the way in which the file manager selects disk drives on a *cyclic* rather than direct basis. As noted in the June 1992 review of LMS version 2.00, the file manager uses the arrow keys to cycle through the available drive letters, rather than allowing the user to simply type in the desired drive (as say, A:).

The problem with the existing arrangement is that if you move from say the C drive (your current work area) to the A drive (to import a file), you must pass through (and momentarily select) the B drive. Invariably, there's not a floppy in the drive and DOS reports an error; suffice to say that the whole system locks up while the errors are cleared.

Since the file manager 'module' is common to both LEAP *and* LMS, this idiosyncracy tends to become quite a pest when the two programs are installed on different machines, in particular. Not a major problem perhaps, but one worth correcting in the next updates for both programs — please, Mr Strahm!

In practice though, the two programs perform their respective jobs in a very elegant manner. A typical speaker development process would begin with measuring the impedance curves for the driver with LMS, and importing this data into LEAP via the file exchange system. LEAP would then derive its model for the driver using the speaker parameter measurement facility, and store the information in its transducer library.

Then you might use LEAP's Quick Cabinet feature to calculate a suggested enclosure design, and use this information to enter a detailed description of your proposed cabinet into LEAP's enclosure library. Using the new driver and cabinet information, LEAP can then perform its analysis routines on the combination, and store the results in its design library. The enclosure design can then be fine tuned for the desired result, while checking the system's theoretical performance with further analysis runs.

Our experience has shown that at this point, LEAP's predictions are accurate

Latest versions of LEAP and LMS

enough to justify building a final cabinet, and any errors are so small that their acoustic effects are usually insignificant. And if the enclosure is of the vented type, by the way, the port length can be slightly altered to pull things into line — all of this can be confirmed by measuring the prototype's performance with LMS, as you would expect.

This process can be repeated until you are fully satisfied with the results, where LEAP is used to develop the proposed changes and LMS employed to check the final outcome. Note that while the above procedure may sound rather convoluted on paper, in practice it all occurs as a logical yet quite simple flow of events.

After that, things can be taken a number of steps further if you are aiming for a multi-way design — thanks to LEAP's ability to handle other more generic drivers (mid-frequency and high-frequency units), and both passive and active crossovers. By using LMS to measure the impedance and frequency response curves of these drivers, LEAP can use this imported data to derive matching models for its analysis routines.

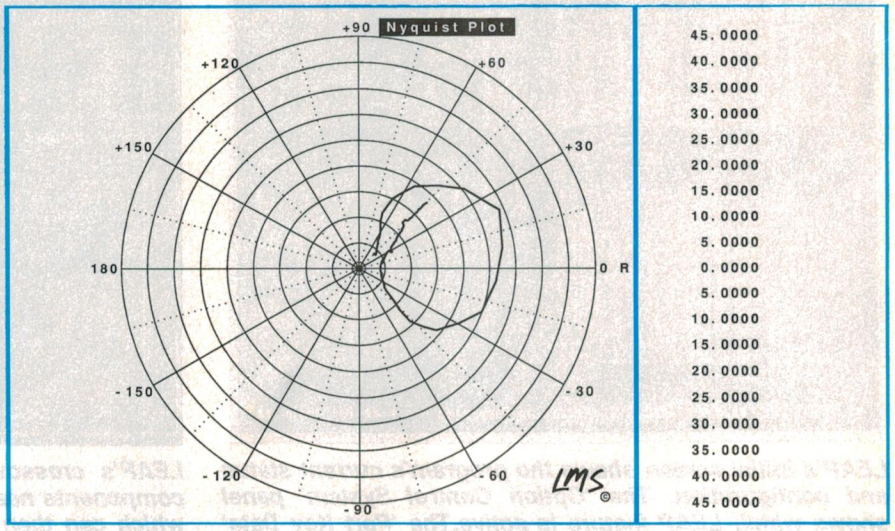
You then have the potential to design a complete multi-way system, which again can be constructed and fine tuned using both programs. By using utilities such as LEAP's crossover designer and filter optimiser, the task is made far easier and much more predictable than traditional manual methods.

Note that in the above example of how the programs might be used to develop a speaker system, LEAP tends to take a larger share of the work load than LMS. This doesn't mean that LMS is any less useful; it's just that our sample task only uses some of the program's capabilities.

Despite the fact that 'loudspeaker' forms part of its name, LMS can be used for a host of other measuring jobs, such as plotting the transfer functions of amplifiers and filter stages, measuring room acoustics and background noise (reverb times as well), and even measuring passive component values at different frequencies.

So all in all, we'd have to say that the current versions of LEAP and LMS represent rather a formidable duo in the loudspeaker design arena. A complete and powerful speaker design and measurement tool can be contained in just one PC, which amongst its other tasks, also serves as a storage area and filing system for your designs.

In the purchase price department,



LMS now offers a Nyquist conversion facility. This printout represents a driver's impedance and phase angle over a range of frequencies, and was derived from a conventional impedance plot.

LEAP and LMS appear to stack up well against other CAD/CAE programs. LEAP version 4.1 is currently available for $1340, and LMS (version 2.0) is priced at $1490 plus $195 for the upgrade to version 3.0. While that's a little over $3000 for the complete package, it would represent a sound investment for anyone who is seriously involved in loudspeaker design and construction.

There's good news too for those who would like to use LEAP on a less professional level, or don't need its full range of features. The local distributor of ATI products, ME Technologies have informed us that LEAP is now available in a modular form — starting with the basic transducer, enclosure and design analysis package at just $449.

This is the core of LEAP, and includes the full analysis and library systems, the Quick Cabinet utility, and all of the normal graphics and printing capabilities.

LEAP's other main features are available as separate 'add-on' modules for $189 each. These are grouped as the Passive Network system, the Active Network system, the Filter Optimiser, Crossover and Conjugate Network designers, the Import and Export system, and the Speaker Parameter Measurement module. So in effect, you can order a customised version of LEAP which suits your exact needs, at an appropriately reduced price. And if your needs change, other modules can be added at a later date.

As it happens, the way in which LEAP's various modules are included is interesting in itself. It seems that regardless of which configuration you decide to buy, the entire LEAP package is really there, and only the appropriate modules 'activated' before you've taken delivery. The configuration of your package is shown on LEAP's initial startup screen, and appears to be totally under the control of the supplied dongle.

The idea of this scheme is that LEAP can be configured (or for that matter reconfigured) by simply programming the dongle itself. So if you decide to buy a new module for your version of LEAP, the distributor can supply you with a simple 'authorisation number' for reprogramming the dongle using a supplied utility program.

ME Technologies are also offering a demonstration version of LEAP for $149, which thanks to the 'intelligent' dongle system, is a *fully* working version for 30 days or 50 program usages (or which ever comes first).

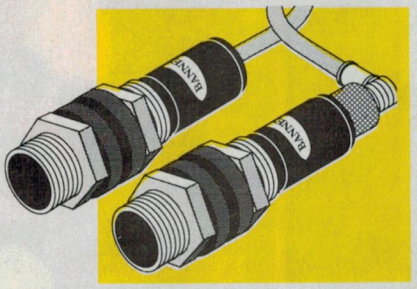
This is an ideal way to try out the package since you are literally dealing with the real thing, rather than some self-running demo program which may look nice on the screen, but provides little feel for the actual program.

And after your trial period has expired, you can either pay for the modules that you need to be re-activated (the $149 is credited to your purchase), or simply send the complete package back to ME Technologies for a refund. You can't complain about *that* deal...

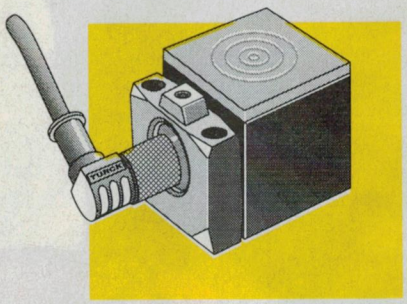
Further information on LEAP and LMS is available by contacting the helpful people at ME Technologies, at PO Box 50, Dyers Crossing, NSW 2429, or phone (065) 50 2341. ❖

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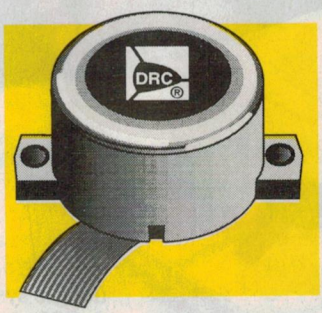
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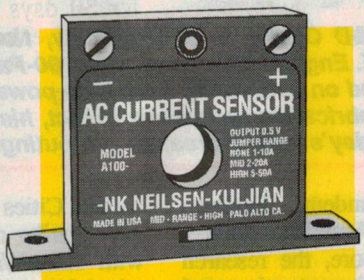
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Electronics Australia's new publication:

PC-BASED CIRCUIT SIMULATORS

AN INTRODUCTION

by JIM ROWE

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A Basic Guide to Colour

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Silicon Valley NEWSLETTER



Bush signs Sematech bill

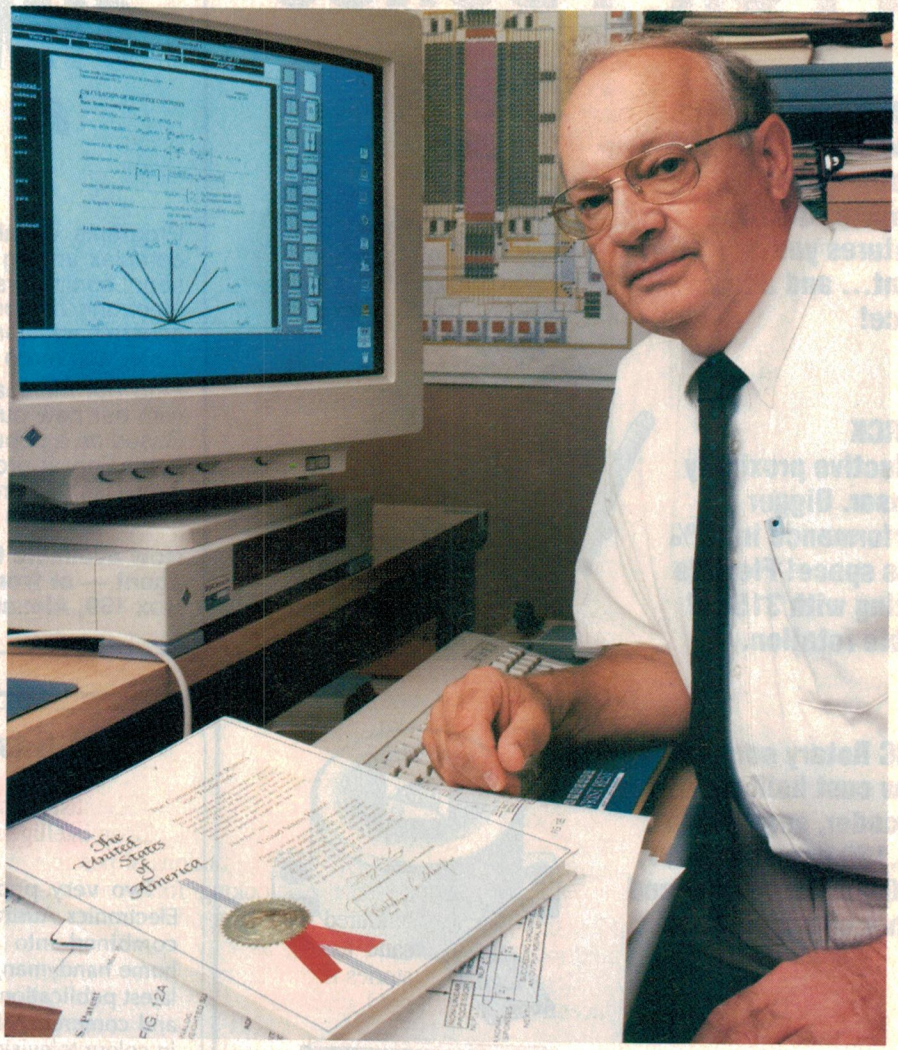
In early October President Bush signed an appropriations bill, giving the Sematech chip research consortium another US$100 million in federal funding. Earlier, Bush had pushed for a 20% reduction in funding for Sematech, an action that could have crippled the group's work.

For the first time, however, the Federal subsidy includes a mandate that Sematech spends at least US$10 million of the Federal funds on research into 'environmentally safe' manufacturing processes. Because Sematech members must match all Federal subsidies, Sematech's budget for environmental research would total US$20 million.

The stipulation is a major victory for environmental groups, who had pushed hard to get Sematech to take the environment into greater concern as part of its research. After Sematech agreed to the arrangement, the environmental groups ended up supporting legislation that would keep Sematech's funding at the US$100 million level.

"We have gone from having a toe in the door to having a seat at the table," said Ted Smith of the Silicon Valley Toxics Coalition, which initiated the effort to get more money earmarked for environmental research.

"The semiconductor industry has been touted as a clean industry. But it uses some of the most dangerous materials in existence and has been the source of unprecedented environmental degradation and workplace hazards," Smith said, citing the fact that Silicon Valley has 39 EPA (Environmental Protection Agency) Superfund clean-up sites, more than in any other industrialised area in the United States.



General Electric's R&D Center in Schenectady, New York has just elected physicist Dr William E. Engeler to its exclusive '100-Patent Club'. Over the years Dr Engeler has worked on everything from high powered lasers for TV camera tubes, IC chips and fabrication processes. In fact, his 100th patent involves an invention in one of today's hottest areas of computing: 'neural networks'.

Major multimedia venture announced

A dozen of the largest high-tech companies in the United States have announced the formation of a consortium aimed at bringing multimedia computer services into the homes of millions of people.

The joint venture, called 'First Cities,' was formed by a group that includes Apple Computer, Tandem, Eastman Kodak and North America Philips. Also included is Bellcore, the research arm of the 'Baby Bell' companies, and Kaleida, the joint Apple-IBM multimedia joint venture.

Among the services First Cities would provide will be interactive home shopping and video libraries that will allow users to order movies from a directory on their television and have their selection beamed directly into their living room via local television cable.

First Cities is one of several ventures with similar objectives. IBM is working with Time Warner and nine major cable television companies to set up a similar service. First Cities is the first effort that involves a cross section of computer telecommunications, and electronics companies. Major entertainment companies are also expected to joint First Cities.

The project was conceived by the Microelectronics & Computer Technology Corp. (MCC), the Texas-based high tech research consortium.

"This is the most comprehensive project of this type," said Apple executive Michael Liebhold, who directs the company's 'media architecture research' department.

No single company will be able to do the job alone, he said, because of the huge financial, technical and legal challenges facing the development of these next generation consumer information and entertainment services.

First Cities will start with a study of the market and evaluation of various available technologies. In the second phase demonstrations of various prototype technologies and services will be set up in several major cities to gauge consumer response.

Intel to build new chip plant

Intel has announced it will invest between US$250 million and US$400 million into a major expansion of its just finished advanced chip research and development facilities in Santa Clara.

The new wing will provide the facility with a major production capability to produce large volumes of Intel's most advanced semiconductors — most notably microprocessors. More than 300 people are expected to be employed at the facility.

To date, the US$250 million R&D centre, which has been in operation for less than two years, has been used mainly for development and prototype production purposes with volume production shifted to other Intel facilities around the US. The new facility will give Silicon Valley its first major new chip production plant since the mid-1980's, when companies started to move production out of the Valley to areas featuring lower labour costs, better infrastructure, less regulation, better investment incentives, and lower cost of living.

Meanwhile, Intel is already planning one of the industry's most elaborate chip facilities, a project that could end up costing the company as much as US$1.5 billion. The project has sparked fierce competition between several states — including Texas, New Mexico, and California, which all hope to end up becoming Intel's choice for the site of the plant.

Super chip helps find intelligent life

NASA's Ames Research Center in Mountain View is organising what will be by far the most ambitious undertaking ever made in the search for intelligent life elsewhere in the Universe. After only three days in operations, the SETI (Search for Extra-terrestrial life) operation had already analysed more data than was collected during some 60 other searches that have been conducted during the last 30 years.

The SETI program is built around a computer that can analyse data from 15 million radio frequencies coming in from the world's largest radio telescopes.

The computer, with an operating speed of up to 50 billion calculations per second, is built around a highly advanced signal and data processing chip that was designed by Jan Duluk while a graduate student at Stanford. The chip reduced the cost of building the SETI supercomputer from an original estimate of US$100 million to just US$1 million.

Duluk and his new Silicon Engines company are now working on a second generation chip that would process 800 million calculations per second.

The SETI computer is so sensitive it can analyse signals that arrive on Earth with the energy of a falling snow flake. And the chip can even pick-up, track and analyse 'drifting' signals that switch from one frequency to another. The computer is programmed to discount normal space background noise. The system will alert scientists whenever it detects a signal that does not fit any of the known profiles. An initial panel of researchers will do a series of tests on any such signals to rule out other possible explanations. Data from signals that cannot be immediately explained will be sent to researchers around the world for verification and analysis.

Kent Gullers, a NASA scientist compares the task of looking for an intelligent signal among the billions of possible frequencies to looking for a single gold-coloured grain of sand in a pile of white sand as big as a football field and 10 stories high. "If one in a trillion grains is gold, we'll find it," Gullers said.

Pirate MS-DOS programs seized

A record haul of 16 truck loads worth of allegedly pirated MS-DOS programs, with a street value of nearly US$10 million, has been seized by US marshals during raids in Silicon Valley and New Jersey.

The 150,000 counterfeit copies of MS-DOS were produced by U-TOP Printing in Sunnyvale. Manuals for the software were printed by Consolidated Printers in Berkeley. Both companies were named in a copyright infringement lawsuit filed by Microsoft following the seizure of the software.

At U-TOP an attorney speaking for the company's owners, James and Shirley Sung, said U-TOP had merely been producing the copies of MS-DOS for computer hardware vendors who presumably had legitimate licences from Microsoft to manufacture the operating system.

According to Microsoft, two of U-TOP's clients, Caliber Computer of Milpitas, and MTD Data Services in Bellevue, Washington were at one time, authorised to manufacture their own copies of MS-DOS. But those licences expired some time ago. U-TOP however, has continued to produce the programs whose packaging closely resemble the Microsoft packaging.

U-TOP attorney Jon Wo said the two companies had provided documents showing that they were still licensed by Microsoft. MTD witheld any comment. A Caliber spokesman said he did not believe his company had ordered the software that was seized.

A Microsoft spokesman said that both firms had told Microsoft they had not authorised the production of the MS-DOS programs. Following several months of investigation by private detectives, Microsoft concluded that U-TOP was producing the programs to sell on its own account.

Atari jumps on multimedia bandwagon

From the list of players, one would easily conclude the multimedia home computer market is vast and booming. After IBM, Apple, and Tandy all released new machines targeted at this segment, struggling Atari also said it has developed a new line of 'Falcon 030' machines for the home.

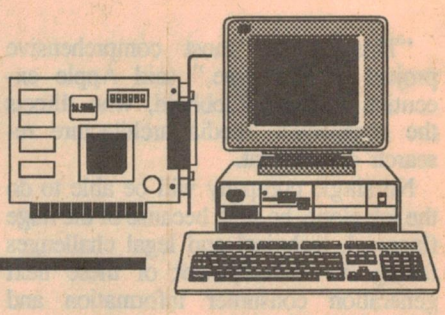
Still, it remains to be seen if the US is ready for multimedia in the home. To date, 26% of US households own a computer. But the vast majority of those are used for business purposes. The new multimedia machines, on the other hand, are more entertainment and education orientated.

Atari's Falcon computer will retail for US$1299. It is built around the Motorola 68030, as well as a Motorola DSP chip used for hi-fi audio and various video and other special effects. It also comes with a 60MB hard drive and 4MB of memory. A CD-ROM drive is optional. A stripped-down version that Atari plans to sell for US$799 will be available in January.

Atari has been struggling financially. It desperately needs a boost in sales from the Falcon Series.

The company still has some US$60 million in cash reserves and plans to use a substantial portion of that for an extensive marketing campaign. ❖

Computer News and New Products



VGA splitters

The VGA output of a computer is designed to drive only one monitor a limited distance from the computer. There are many instances where this inadequacy proves inconvenient and annoying. 'Twinsplit', 'Quadsplit', and 'Octosplit' gives you the ability to split a single VGA signal to either two, four or eight monitors simultaneously. Perfect for conference and industrial use, the units are compatible with PS/2's and any VGA board.

Each VGA monitor may be connected directly into these VGA splitters or located up to 60 metres away using optional extension cables. Short and long gain switches are located on the front panels to compensate for the cable loss for each monitor. The VGA splitters may be located up to 1.8 metres from the computer.

The optional cables are simple to install, one-piece low loss multi-coax assemblies which eliminate the need to run separate RGB coax cables to each monitor.

The VGA splitter may be combined with a 'VGA Extender' for long distance remote monitoring and keyboard control, for distances up to 300 metres.

For further information circle 162 on the reader service coupon or contact Boston Technology, PO Box 415, Milsons Point 2061; phone (02) 955 4765.

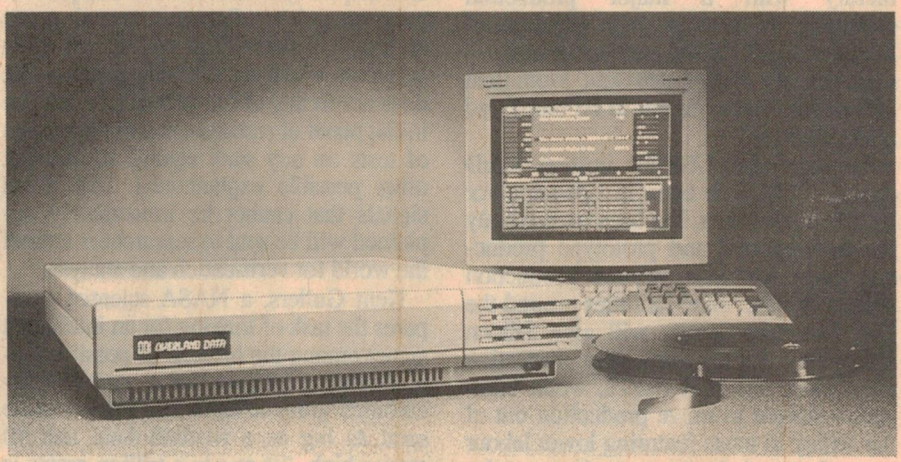
Compact 9-track tape drives

Overland Data has introduced its new Tape-Pro series of ultracompact high-density (6250bpi) 9-track tape drives. The Tape-Pro drives allow users to exchange data stored on 9-track tape among mid-range and mainframe computers, PC's and UNIX-based workstations.

Designed for the modern office, the new drives are only 9cm high, weigh under 14kg, operate quietly and can either sit on a desktop, or be mounted in a rack for computer room use. The 3000 Series drives support Pertec/Cipher plus Parallel Port interfacing, whereas the 5000 Series drives support Pertec/Cipher, Parallel Port and SCSI. Data compression is provided with the SCSI models, which can increase 9-track capacity by two to five times, depending on the type of data stored.

One full megabyte of cache memory is provided with Tape-Pro drives. The combination of caching and tape speed optimisation ensures maximum data transfer performance and eliminates CPU and disk drive delays.

For further information circle 161 on the reader services coupon or contact Elmeasco, PO Box 30, Concord 2137; phone (02) 736 2888.



ISDN line monitor

Macro Dynamics has released the MIC-64k, a small portable ISDN motor intended for both field and laboratory use. This on-line monitor can record data, in real-time, into the 128K bytes of capture memory. It supports Dual-Duplex (DUAL) and different models of data and status, as well as displaying IDLE time below 19.2kbps. Protocols include LAP-D layer 2, layer 3 and LAP-B frame and packet analysis. Interfaces supported are ISDN Basic Interface (CCITT 1.430), RS232C (CCITT V.24/V.28) and TTL levels. Additionally, the monitor includes SYNC/ASYNC (5, 6, 7, 8 bit) and HDLC (8-bit) mode support.

The trigger for the real-time trace capture can be on any character or string (up to eight characters), detection of error in parity, BCC and Abort. Time of day data is inserted when monitoring starts. The maximum transmission speed supported is 64kbps with clock selection ST1, ST2, RT, APC. The internal clock has the range 50 through to 38,400bps. The data is displayed on the 32 x 14 character LCD display, or transferred directly to a printer via a built-in Centronics interface. LED indicators show interface signals, such as RS, CS, CD and DR.

For further information circle 164 on the reader service coupon or contact Macro Dynamics, 322 Mountain Highway, Wantirna 3152; phone (03) 720 2399.

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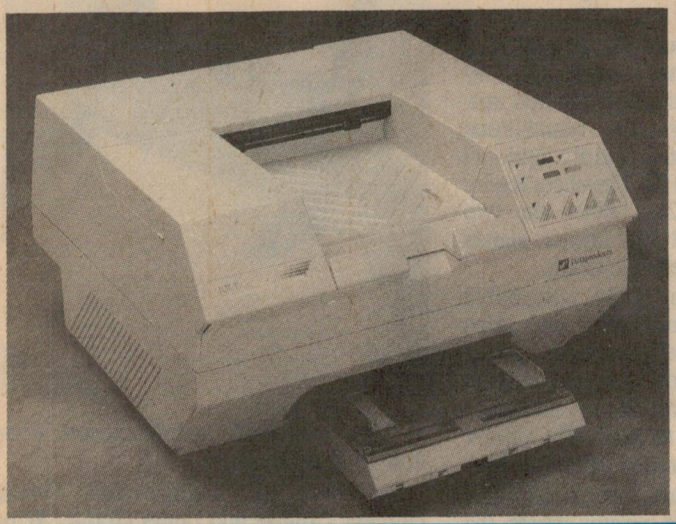
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READER INFO NO. 39

Solid ink colour printer

US Dataproducts Corporation has released JOLT, a colour printer that enables a variety of users to integrate colour with black text on almost any media.

JOLT incorporates Dataproducts' proprietary Solid Ink technology, which enables the printer to produce laser quality black text mixed with vibrant colour on a wide range of papers, from the finest bond to recycled stock.



JOLT will be available in Australia in two versions. The first for IBM and compatible PC's, supports Microsoft Windows applications. It incorporates Dataproducts' JOLT native mode, and is software-compatible with Hewlett Packard's PCL4 (with PCL3 colour extensions) and 7475A plotter emulations. It comes as standard with 1MB of memory and features a Motorola 68000 processor with a 10MHz clock. Depending on the application, it supports up to 33,392 colours.

JOLT PS, the second version, comes with true Abode PostScript Level 2 page description language, and is compatible with IBM PC's and Apple Macintosh computers. JOLT PS uses a Weitek 8220 RISC processor with a 24MHz clock for fast throughput. It supports 16.7 million colours, and with 6MB of memory is ideal for complex colour applications in the office and studio.

Both JOLT versions produce laser quality (300dpi) letters, memoranda and text at around two pages per minute, part colour and text at around one page per minute and complex full colour drawings at 0.7 pages per minute. JOLT is priced at $6995, with JOLT PS at $8995 — both prices including tax.

For further information circle 165 on the reader service coupon or contact Dataproducts, 10 Rodborough Road, Frenchs Forest 2086; phone (02) 451 3533.

Fast graphics board

An exceptionally fast graphics board, the #9GXi-L20, based on the high performance TI 34020 32-bit processor is now available from TCG for $1100. The powerful new 32-bit 10MIPs, TI 34020 processor gives speeds of up to 20 times those of existing boards using the industry standard 16-bit TI 34010 processors.

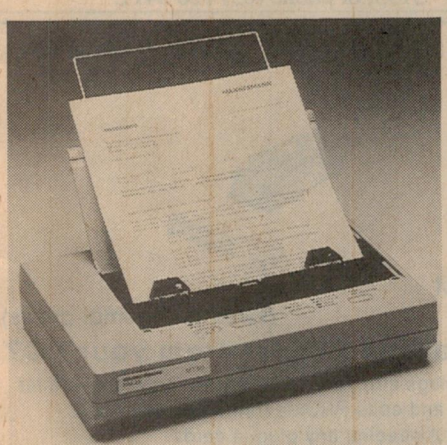
Optimised for graphics functions, the TI 34020 dramatically improves the time taken for zooms, pans, redraws and other CAD applications.

Graphics commands normally performed by the Display List Processor can be executed instantaneously on the intelligent #9GXi coprocessor. The host CPU is then freed up to more quickly process non-graphics orientated data, resulting in dramatic reduction in user wait time. Users have a choice of selectable resolutions from 512 x 480 to 1280 x 1024, and a choice of up to 16.8 million displayable colours for realistic shading and rendering applications.

For further information circle 177 on the reader service coupon or contact TCG, 30 Balfour Street, Chippendale 2008; phone (02) 699 8300.

Compact bubblejet

Siemens has launched the new Mannesmann Tally portable bubblejet printer, aimed at users looking for more performance than currently offered in the low cost portable arena. Known as the MT99, the printer bridges the gap between the top end of the portable printer market, represented by the company's MT1735, and the alternative low cost portable products such as the Canon BJ10e.



Owing to its compact size, rugged design, high speed (200cps) and DeskJet emulation, the printer is suited for use as a portable device or as a desktop printer. It has an integral sheetfeeder that folds completely away to enable ease of transportation, and which allows continuous cut-sheet printing without recourse to add-on devices.

The MT99 uses standard camcorder batteries in a battery pack which can provide 50 minutes of continuous printing. This type of battery is a relatively low cost power solution and provides access to a wide range of options such as fast charge and car charging units. the combined printhead and ink cartridge is a no-mess disposable unit that prints up to 800 pages of letter quality text in sharp black ink characters. The printer also keeps track of ink levels.

For further information circle 166 on the reader service coupon or contact Siemens Advanced Information Products, 544 Church Street, Richmond 3121; phone (008) 032 954.

GPIB 'Smart cable'

The recently released GPIB Smart Cable from Pamcart allows simple direct connection of GPIB instruments to a PC via the standard parallel printer port.

No internal PC cards or additional hardware are required, and the cable may be freely moved from PC to PC without the complications of internal card compatibility. The Smart Cable allows GPIB operation from Lap Top PC's, which often can't take an internal card.

The Smart Cable printer port connector contains a 44-pin PLD device and all level shifting and buffering circuitry necessary to convert TTL parallel port signal levels to bi-directional GPIB bus levels. It is powered from the printer port itself and requires no additional external power supply. Software drivers are included for Microsoft Quick BASIC 4.5, and library modules are available for other Microsoft languages including Pascal and C. Also included is interactive communication and debug software. Instruments that may be controlled typically include DMM's, digital oscilloscopes and recorders.

COMPUTER PRODUCTS

For further information circle 167 on the reader service coupon or contact Pamcart, 76 Ryans Road, Umina 2257; phone (043) 42 1250.

PLC for Fischertechnik

Procon Technology has released a version of the PLC (Programmable Logic Control) language for use with the Fischertechnik computer kits.

Version 2.50 for the IBM-PC or 'compatibles' is a relay ladder logic programming language that supports eight micro-switch inputs, eight solid-state outputs (or four bi-directional motor outputs), 64 internal control relays, eight timers and eight counters with program sizes up to 1000 ladders. Scan rates up to 500 times per second are possible, allowing it to control the Fischertechnik robot with its rotary encoder running at 200 pulses per second.

The PLC editor facilitates the entering, deleting and modification of ladder logic off-line or on-line. On-line editing allows modifications to be made to the program whilst it continues to run, e.g., a time delay could be adjusted or a logic error could be corrected.

The editor also allows the monitoring of logic conditions, time delays and count values — again with no interruption to program execution.

Once a program has been debugged, it can be loaded for execution in background (as a memory-resident program) whilst the computer is used for other things.

The latest version of PLC software is available for a special introductory price of $99. Other versions are expected to be released shortly for the LEGO Technic Control system and for electronic enthusiasts who wish to construct their own interface connected to the printer port.

For further information circle 169 on the reader service coupon or contact Procon Technology, PO Box 655, Mt Waverley 3149; phone (03) 807 5660.

Compact portable inkjet printer

Hewlett-Packard has introduced its HP DeskJet Portable printer which offers the same performance and laser quality printing as the HP DeskJet 500 printer, in a compact 2kg design.

The printer is about half the size of a notebook PC, and may be purchased by itself or with an optional automatic cut-sheet paper feeder. The stand-alone printer is $954 plus tax, and the optional cut-sheet feeder is $153. The sheet feeder also weighs about 2kg. When the two units are assembled the printer stands upright at a 45° angle for printing.

It connects to any IBM compatible computer via a parallel port and ships with a custom designed, low profile parallel cable. Unlike most standard parallel cables that are rigid and bulky, this cable is flexible and easy to pack. The printer also works with a standard parallel cable.

Based on thermal inkjet technology, the HP DeskJet Portable printer meets the same quality and performance standards as all HP DeskJet brand printers. It provides 300dpi resolution, prints up to three pages per minute, and is supported by all major DOS and Microsoft Windows 3.X applications.



Built in fonts include CG Times, Univers, Courier and Letter Gothic. Windows 3.1 users can also print scalable TrueType fonts.

For further information ring Hewlett-Packard on (008) 033 821.

Parallel-to-serial high speed converter

The new ASeries A515 is a Centronics parallel to RS-422 high-speed serial protocol converter. Low in cost, it is designed and manufactured in Australia to the highest quality.

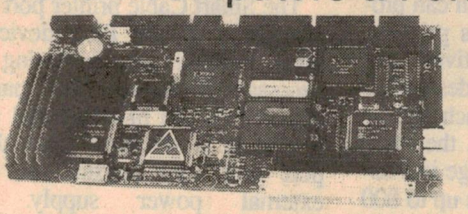
Used in pairs, two A515's will transfer data at 460kbps with an effective data throughput of 30,000 characters per second. This can be reliably achieved at a distance of up to 300 metres.

Cabling is via an RJ-45 connector for RS-422, and only four wires plus the ground wire are used. This makes the unit particularly useful in a PDS cabling environment where reliable high speed parallel data transmission is required.

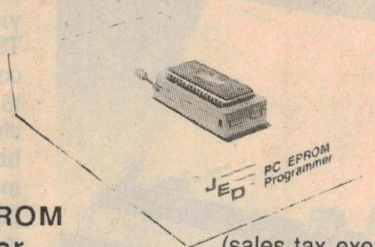
Unlike the simple unpowered line extenders, the A515 uses an Australian approved power adaptor to guarantee that data is actually transmitted. When graphics data is transmitted on simple unpowered devices, some of the data is lost — when, for example, a string of 'null' characters is sent.

For further information circle 170 on the reader service coupon or contact Alfatron, 5/14 Jersey Road, Bayswater 3153; or phone (03) 720 5411.

Australian Computers & Peripherals from JED... Call for data sheets.



The JED 386SX embeddable single board computer can run with IDE and floppy disks, or from on-board RAM and PROM disk. It has Over 80 I/O lines for control tasks as well as standard PC I/O. Drawing only 4 watts, it runs off batteries and hides in sealed boxes in dusty or hot sites.
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Office 7, 5/7 Chandler Rd., Boronia, Vic. 3155. Phone: (03) 762 3588 Fax: (03) 762 5499

READER INFO NO. 40

Satellite training PC card

The Model GPS-PC is a single card, PC-compatible, timing receiver/generator. This versatile card occupies one card slot in any IBM XT or AT (or compatible), and can be synchronised to UTC by the GPS satellite system, as well as operate as a stand-alone generator.

The addition of this PC plug-in card to a personal computer-based data collection/monitoring system will add a precision clock whose time is based on GPS. This receiver/generator will provide time information from tenths of milliseconds through hundreds-of-days, as well as the quality of the provided time information.

The international timing is synchronised to UTC to better than five microseconds. The synchronisation process also measures the frequency difference between the internal oscillator and the input code. If the GPS input code should fail, this information is used to correct the oscillator and maintain accurate timing across periods of input failure. When the user wishes to read the time from the GPS-PC, a 'freeze' command is sent and the time is saved in a scratch pad RAM. The time will remain static until the user clears the freeze command. The RAM may be read at any time.

User programming switches provide control over the output format (BCD or ASCII data) as well as the address of the board. Included in a 5-1/4", 360K disk with a 'TIME.DOC' file to assist in set up and operation, as well as a sample program in BASIC for time retrieval.

For further information circle 180 on the reader service coupon or contact Rohde & Schwarz Australia, 63 Parramatta Road, Silverwater 2141; phone (02) 748 0155.

Smart RS-485 node

Black Box Catalog has introduced a new RS-485 device, the SmartNode, which can be used to add RS-232 dumb devices to a parallel RS-485 network, extending up to 1500 metres. It can also be used to build a network.

It enables all types of asynchronous RS-232 equipment, such as dump terminals, scales, printers, lathes, barcode readers and lab instruments to be addressed. The drives can be added, without modification, to communicate on an RS-485 multidrop network at speeds up to 38.4kbps. They are simply attached to the network as RS-485 devices.

For further information circle 175 on the reader service coupon or contact Black Box Catalog, 21-23 Maroondah Highway, Croydon 3136; phone (03) 879 7100.

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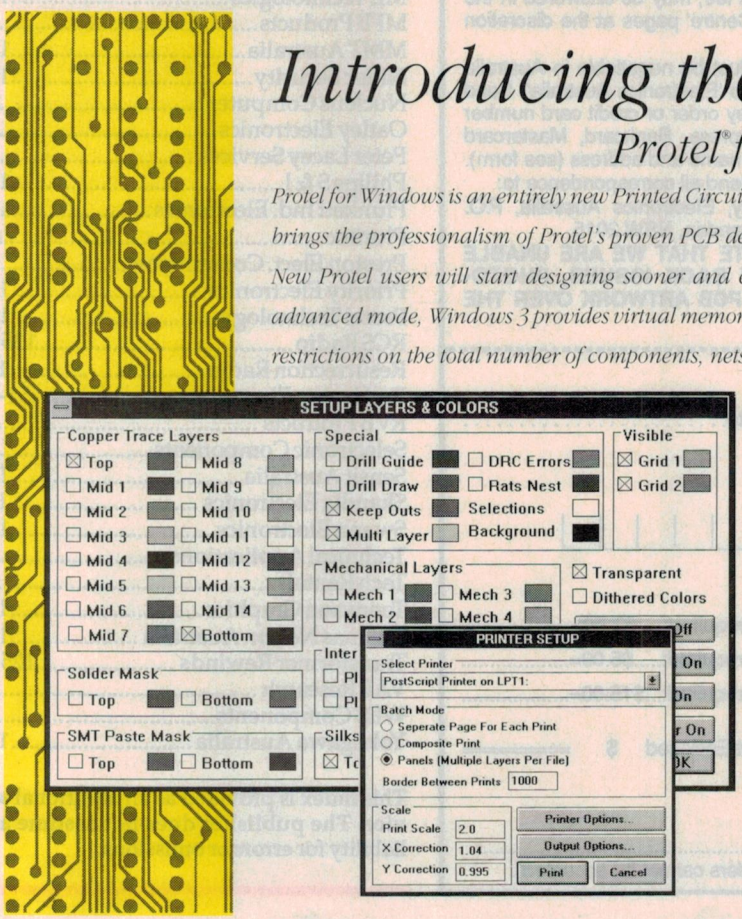
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